CALIFORNIA ENVIRONMENTAL CONTAMINANT BIOMONITORING PROGRAM

(BIOMONITORING CALIFORNIA)

SCIENTIFIC GUIDANCE PANEL MEETING

CONVENED VIA HYBRID FORMAT BY:

OFFICE OF ENVIRONMENTAL HEALTH HAZARD ASSESSMENT

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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Yan Lin, PhD, Postdoctoral Associate, Duke Global Health Institute

Wendy Linck, PG, PMP, Division of Water Quality, California State Water Resources Control Board

ALSO PRESENT:

Nancy Buermeyer, Breast Cancer Prevention Partners

Shoba Iyer, PhD, San Francisco Environment Department

Ahimsa Porter Sumchai, PhD, Hunters Point Community Biomonitoring Program

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PROCEEDINGS

DR. DAVE EDWARDS: Well, good afternoon. I would like to welcome Panel members and the audience to the March meeting of the Scientific Guidance Panel for Biomonitoring California, more formally known as the California Environmental Contaminant Biomonitoring Program. Thank you all for joining us today.

The Panel last met on November 6th, 2023, where two meetings were held. So as a reminder, the August 2023 meeting was rescheduled to the morning of November 6th following an emergency proclamation of extreme weather. The rescheduled August meeting included updates on Biomonitoring California Program activities including PFAS detection methods in serum and plasma. The Panel also considered the expansion of the PFASs designated chemical group. The Panel voted unanimously to recommend that the chemical group perfluoroalkyl and polyfluoroalkyl substances (PFASs) and other substances with carbon-fluorine bonds be included as designated chemicals for Biomonitoring California.

In making this recommendation, Panel members highlighted: the importance of capturing exposure potential of chemicals with carbon-fluorine bonds through biomonitoring data; the benefits of increased flexibility for the Program to identify exposures to chemicals with

carbon-fluorine bonds through non-targeted analyses; and the need for the Program to carefully review the chemical properties and exposure data specific to individual chemicals in this group when determining which chemicals to include in future biomonitoring studies.

So that was the first meeting, or the August meeting.

So then this next meeting on the afternoon of November 6th, we -- the SGP met for regularly scheduled November meeting. The meeting included updates on AB 617 community biomonitoring studies, including results from the Stockton Air Pollution Exposure Project, or SAPEP.

Key discussion topics included: evaluating the impact of the swamp cooler filters and portable air cleaners installed at participants' homes during the FRESSCA-Mujeres study, and the potential for follow-up with study participants.

Topics related to SAPEP included: interpretation of the data for biomarkers of oxidative stress and inflammation; interpreting the 2-naphthol results in urine samples; database to help identify potential sources of naphthalene or carbaryl in the Stockton area; and lastly, key concepts to communicate to participants and the larger community when sharing study findings. So the summaries and transcripts of both of these meetings are posted on

their respective meeting pages on the Program's website at biomonitoring.ca.gov.

I also want to take the time to recognize that during the COVID-19 pandemic Biomonitoring California turned 15. Now that we are meeting in person again, we are taking the opportunity to celebrate at a reception here at Dharma College following this meeting's conclusion. To those of you attending today's meeting in person or tuning in from nearby, we hope you will join us. There will be some toasts and brief remarks at the event, but I thought I would highlight some of the key accomplishments of the Program in its first 15 years.

These include: conducting nearly 30 studies in almost 8,000 Californians looking at chemicals such as metals, phenols, PAHs, and PFASs; collaborating with over 50 community organizations to understand how biomonitoring can address exposure concerns in their communities and designing studies to identify unequally exposed subpopulations; maintaining and updating the lists of designated and priority chemicals to keep up with the constantly growing numbers of chemicals of concern on the market; developing over 35 chemical fact sheets including lead, organophosphate, pesticides, and BPA in multiple languages; and lastly, upholding the Program's mandate to return biomonitoring results to participants in a

culturally and linguistically appropriate way, so they understand their exposure levels and how to reduce their exposures.

On behalf of OEHHA, CDPH and DTSC, thank you to the Scientific Guidance Panel and to the staff of Biomonitoring California for your continued service to Californians. We look forward to the next 15 years of the Program and to seeing you at the celebration. Event details are on the March SGP meeting page.

Okay. So before I invite the Panel members to introduce themselves, I would like to announce that Amy Padula was appointed by the Speaker of the Assembly, Robert Rivas, as Scientific Guidance Panel member in January. Amy Padula is an Associate Professor in the Department of Obstetrics, Gynecology, and Reproductive Science at the University of California, San Francisco. Her expertise is in epidemiologic studies of environmental exposures, social inequalities, and adverse pregnancy outcomes. Dr. Padula was awarded the Outstanding New Environmental Scientist Award from the National Institute of Environmental Health Science to investigate the impacts of wildfires on preterm birth in California. As part of the National Institute of Health's Environmental influences on Child Health Outcomes, or the ECHO study, she investigated associations between PFASs and other

endocrine-disrupting chemicals in combination with social stressors during pregnancy and their effects on adverse birth and child health outcomes. She has also worked with the Silent Spring Institute to report back individual chemical exposures to study participants.

Dr. Padula received her PhD in Epidemiology from the University of California, Berkeley, and completed her post-doctoral training at Stanford University. Welcome, Amy.

All right. I should also announce that Meg Schwarzman, who is our SGP Chair, will resign as a Panel member to give more attention to her many other commitments after this meeting. She was appointed by the Speaker of the Assembly in 2014 and has been an outstanding member of the SGP for the past 10 years. She has been the Chair of the Panel since 2017. We want to thank Meg for her leadership and guidance and for her service to the people of California. We wish her the very best in her future endeavors.

(Applause).

DR. DAVE EDWARDS: All right. So I will now invite the Panel members to introduce themselves by name and affiliation.

Let's start with José Suárez who is attending remotely.

PANEL MEMBER SUÁREZ: Good afternoon. I'm José Suárez, Associate Professor in the Division of Climate and Environmental Health within the Herbert Wertheim School of Public Health at the University of California, San Diego.

DR. DAVE EDWARDS: Great. Thanks, José.

Carl Cranor.

PANEL MEMBER CRANOR: I'm Carl Cranor, a legal philosopher with an appointment in Environmental Toxicology at the University of California, Riverside.

DR. DAVE EDWARDS: Oliver Fiehn.

PANEL MEMBER FIEHN: Hello. I'm Oliver Fiehn, Professor at the Genome Center at University of California, Davis.

DR. DAVE EDWARDS: Ulrike Luderer.

PANEL MEMBER LUDERER: Hi. I'm Ulrike Luderer. I'm Professor in the Department of Environmental and Occupational Health at the University of California, Irvine.

DR. DAVE EDWARDS: All right. Tom McKone.

PANEL MEMBER McKONE: I'm Thomas McKone, or Tom I go by. I'm Professor Emeritus at the School of Public Health at the University of California, Berkeley and also a retired affiliate at Lawrence Berkeley National Laboratory.

DR. DAVE EDWARDS: Amy Padula.

PANEL MEMBER PADULA: Hi. I'm Amy Padula. I'm an Associate Professor in the Department of Obstetrics, Gynecology, and Reproductive Sciences.

DR. DAVE EDWARDS: Thank you. And Meg Schwarzman.

CHAIR SCHWARZMAN: Thanks. I'm Meg Schwarzman, faculty at UC Berkeley, Environmental Health Sciences Division.

DR. DAVE EDWARDS: Great. It looks like we have a quorum. So now I will hand this off to Panel Chair Meg Schwarzman who will provide more details about this afternoon's meeting.

CHAIR SCHWARZMAN: Thank you, Dave. And it's hard to leave, but we still have today's meeting and I want to start with meeting logistics.

So a reminder to Panel members to please comply with Bagley-Keene Open Meeting requirements that all discussions and deliberations of the Panel and the subject matter that we're dealing with today be conducted during the meeting, not on breaks, or with individual members of the Panel either on- or off-line, including via phone, email, chats, or text messages.

Panel members attending remotely must visibly appear on camera during the open portion of the meeting. If you're unable to keep your camera on at any point

during the meeting because of technological impracticability, please make an announcement when you turn your camera off. And also, if someone older than 18 is in the room with any panelists attending remotely, you have to disclose the presence of that person and their general relationship to you. So we'll pause for a moment. I think we only have one remote attendee, and we should -- if you could just confirm whether anyone over 18 is in the room with you, José.

PANEL MEMBER SUÁREZ: (Shakes head).

CHAIR SCHWARZMAN: No one. Thank you very much.

Okay. So our Panel goals for today, we're going to first hear an update on Program activities, including the initial results of a project to assess associations between per- and polyfluoroalkyl substances, PFAS, levels in serum in Southern California adults and the associations with drinking water levels.

Later this afternoon, we'll also hear from guest speakers on challenges and opportunities for biomonitoring for oil and gas exposures. Two topics for today.

There will be time from -- for questions from both the Panel members and audience after each presentation, and then a separate discussion session for each block.

If SGP members wish to speak or ask a question,

please just raise your hand, if you're in the room, and I'll call on you. If online webinar attendees have questions or comments during the question period after each talk, you can submit them via Q&A feature of the Zoom webinar, or by email to biomonitoring@oehha.ca.gov. We won't be using the chat function. Please keep your comments brief and focused under -- on the items under discussion for today and we'll read allowed relevant comments and paraphrase them, if necessary.

Online attendees who wish to speak during the public comment periods or discussion sessions, please use the raise hand feature in Zoom. And Rebecca Belloso will call on you when it's the right time. If you're attending in person and you want to comment during the public comment periods or discussion sessions, please come to the front or raise your hand and we'll call on you. For the benefit of the transcriber, please clearly identify yourself before providing your comment and write your name and affiliation on the sign-in sheet that's at the back of the room to verify that we have your name right.

Okay. I think that's all the meeting logistics. And I want to introduce our first speaker, who is Nerissa Wu, Chief of the Exposure Assessment Section in the Environmental Health Investigations Branch, or EHIB, at the California Department of Public Health. The

overall -- she's the overall lead for Biomonitoring California and will provide an update on current Program activities.

(Thereupon a slide presentation).

MCKENNA THOMPSON: One second.

DR. NERISSA WU: Thank you so much.

Good morning, everyone -- or good afternoon, rather. Good to see you all here. I have 10 minutes for my Program update, because we have a really packed agenda, so I am going to be going through this kind of super speed, but, of course, open to answering questions later on.

[SLIDE CHANGE]

DR. NERISSA WU: I'll spend some time talking about our different projects, our surveillance projects, as well as our community-focused work. I'll give you some lab updates, as well as updates to our Designated Chemical list, and then a brief report back from the National Biomonitoring Network meeting.

[SLIDE CHANGE]

DR. NERISSA WU: So starting off with our surveillance work, the CARE Study, the California Regional Exposure Study, which biomonitored participants in south and southeastern California from 2017 to 2019. The data from the CARE study is now being used in analyses looking

at the associations between serum PFAS levels and drinking water sources and reported dietary information. And Toki Fillman is going to be talking about this in detail after I speak, so I won't go into anymore detail.

We are just initiating analyses of the metal data and potential exposure sources. So any suggestions on associations to investigate are welcome. In addition to information on participant residence and demographics, we also have information on their home characteristics, drinking water habits, diet, occupation, hobbies, smoking, reproductive history and more. In addition to these things, our lab is also working to generate its -- to generate speciated arsenic and phenols data, so that we'll have population data for those panels.

[SLIDE CHANGE]

DR. NERISSA WU: We have scheduled an open webinar for the CARE study to present study findings publicly and that's on April 18th, and we'll be sending out information on this webinar to our website listserv, to all study participants, and to our general mailing list. So if you don't typically get mail from us and you're interested in this webinar, please reach out to us and we will get the information to you. The report is available in both English and Spanish and it's ready to post on our website in the next few days.

[SLIDE CHANGE]

DR. NERISSA WU: Also, on surveillance, we have our two biobanked based surveillance projects, MAMAS and STEPS, both of which used prenatal screening samples from the Genetic Disease Screening Program. MAMAS has samples from 2012, 2015, and 2016 from different parts of the State, as shown on the map. And samples from that study were analyzed either for POPs or for PFASs. We did not have any samples for which both analyses were run. So the summary statistics for MAMAS have been posted on the web. MAMAS 2 and 3 are in the queue and will be posted soon.

And we've done some analyses of the data and found that, as expected, consistent with national data, the general PFAS levels are going down between 2012 and 2016, but there are some exceptions. PFUnDA and PFDA did not really change during this time, so that's a little bit different. And also, for PFBS, the four-chain -- the four-carbon PFAS, it went up slightly in MAMAS 3. It's hard to know what that means. These are in different geographic areas, but it's something to keep an eye on for STEPS.

[SLIDE CHANGE]

DR. NERISSA WU: And STEPS is the follow-up to MAMAS for which we have representative samples from Orange and Fresno counties from 2015, 2018, and 2021. So we've

got a thousand samples for STEPS in the queue at the lab. And we're happy to report that we were successful in developing a protocol with the Genetic Disease Biobank that we're using to save samples from the 2024 pregnancies from Los Angeles County.

[SLIDE CHANGE]

DR. NERISSA WU: So for Orange and Fresno counties, we selected samples from the pool of eligible participants, because we already had information from the birth record. But because LA County is not part of Biobank, and the samples are discarded after they undergo prenatal screening, we're grabbing them now from the 2024 pregnancies. We're oversampling because of this. And then once we have the birth record in one to two years, we'll apply our eligibility criteria. And that will give us a parallel group of samples from Los Angeles, giving us a comparison across three counties. And our plan is to continue sampling in 2024 and 2027, so we have this nice temporal trend across three counties.

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DR. NERISSA WU: Moving on to our community focused studies and the ACE Project, which focused on the Chinese and Vietnamese communities in San Francisco and San Jose. The analyses of the questionnaire data has been focused on fish consumption and we have some very

important results, strong associations between fish consumption and serum PFAS levels. Depending on the types of fish and the fish parts consumed have associations with six different PFASs from 9 to 124 percent, depending again on what kind of fish and the fish parts that are consumed. We have shared results with State and federal partners, and the evidence of this elevated serum level for this community as well as the information on fish consumption has been really compelling. It's generated some very important conversations about fish advisories and how to protect California communities. This will be presented at a future SGP meeting.

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DR. NERISSA WU: There's a lot of activity also on our community biomonitoring studies in AB 617 communities. Results for VOC metabolites were returned to the East Bay Diesel Project participants. In SAPEP, we've presented in our last meeting how we've continued to work to understand the results. We do have a new lab result, as of yesterday, to help us interpret the 1 -- the 2-naphthol data. But we just got it yesterday, so we don't really have anything to say about that quite yet. And then FRESSCA and BiomSPHERE, the lab is working on the urine samples and staff is evaluating air monitoring and questionnaire data.

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DR. NERISSA WU: At the Environmental Health Lab, they have received and aliquoted samples from FRESSCA and BiomSPHERE. They're also measuring specific gravity on all samples so that we can do dilution correction. And as I mentioned earlier, they're busy working on phenols and speciated arsenic analyses for CARE-LA.

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DR. NERISSA WU: They've also made a lot of progress on the method development. They have an improved PAH panel, which just passed proficiency testing. And we're in our final stage of validation, which for our Program is to run it through the Intra-Program Pilot Study, which is really analyses through results return, which will then enable us to include it on a study. Similar for VOC metabolites, they just passed proficiency testing, which is awesome. And the IPP samples are also being analyzed for VOC metabolites. So both of those panels should be available for studies.

[SLIDE CHANGE]

DR. NERISSA WU: Over at the Environmental Chemistry Lab, as I mentioned, the staff is working on our STEPS Study, which we keep adding to, so that queue is quite long. For method development, there has been a lot of progress on the cyclosiloxane method for serum. And

we'll be going into validation soon. PAHs in serum continues to make progress. And the method to look at total fluorine in consumer products, carpets, rugs, and protective sprays is also going into validation, not a biomonitoring method, but we hope to introduce it into biological materials soon.

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DR. NERISSA WU: And related to the lab development, we also have updated our Designated and Priority Chemical lists. We modified the group as mentioned earlier today. And in place of PFASs, it is now PFASs and other substances with a carbon-fluorine bond, and the Designated list is also updated to keep us current with the CDC list.

[SLIDE CHANGE]

DR. NERISSA WU: And just briefly on the National Biomonitoring Network, this is a conference that was held in January. It's an opportunity to meet with other State programs, work with them to talk about things like participant recruitment, questionnaire writing, analytical approaches, et cetera. California presented as part of a workshop on results communication. We were part of a panel on PFASs at which our fish and the drinking water that you're going to hear about were presented. And then we were on a panel on paving the road to a permanent

biomonitoring program. You can see from the map, the network has really expanded in the past few years.

There are many states working to set up a biomonitoring program and other states hoping to transition from grant funded to a permanent State-funded program. And California is the oldest most established State Biomonitoring Program. And as such, we're really positioned to provide support and guidance to the other states. We're also, having completed 15 years as a program, really transitioning into a more mature program with established collaborations, and methods, and the ability to use our data to demonstrate exposures as well as start identifying exposure sources. So it's very exciting to be at this point. And it really couldn't be done without these folks --

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DR. NERISSA WU: -- our amazing staff. And we have couple of additions to just highlight. Aalekhya Reddam, he is here, a new epidemiologist over at OEHHA. Eimi Percival is an APHL Fellow who has joined DTSC. And Sayaka Takaku-Pugh has joined as a new supervisor in June-Soo's group. So thank you to new staff. We're really excited to work with you and thanks, of course, to our existing staff. And that was it. I will answer questions I think after Toki's presentation.

CHAIR SCHWARZMAN: Yes. Thank you. I want to introduce Toki Fillman, a research scientist in Environmental Health Investigations Branch, EHIB, also at CDPH. She'll give a presentation on the initial results of the associations between PFAS levels in drinking water and serum, among Southern California adults.

(Thereupon a slide presentation).

TOKI FILLMAN: Perfect. Thank you.

Good afternoon. My name is Toki Fillman and I'm a Research Scientist with Biomonitoring California. And today, I'm very excited to be able to share with you some of our initial results in a project that I have been a part of, focusing on the associations between PFASs in drinking water and serum among Southern California adults.

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TOKI FILLMAN: Human exposure to PFASs can occur through several different pathways. So these can include contact with personal care products or consumer products, such as disposable food packaging, cookware, waterproof outdoor gear, or stain or water resistant furniture or carpeting, also through inhalation of dust in the home, ingestion via the diet, and one of the major exposure pathways is also through drinking PFAS-contaminated drinking water, which is the focus of this work.

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TOKI FILLMAN: Although California does not yet have maximum contaminant levels for drinking water, last year, the EPA did propose national primary drinking water regulation for PFASs, specifically for PFOA and PFOS as individual contaminants and PFNA, PFHxS, PFBS, and GenX chemicals as a chemical mixture. And the EPA is expected to finalize these drinking water regulations very soon.

[SLIDE CHANGE]

TOKI FILLMAN: Studies from areas with high level contamination due to industrial manufacturing have reported significant contributions of drinking water to overall PFAS exposure. However, few studies have focused on the general population in areas without industrial manufacturing such as in California.

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TOKI FILLMAN: So the objective of our current study is to estimate the contribution of PFAS detections in drinking water to the concentration of PFASs in serum among a general population of adults in California.

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TOKI FILLMAN: This is work that came out of one of our biomonitoring studies, the California Regional Exposure, or CARE, Study. So the CARE study was a surveillance study was -- that was carried out between 2018 and 2020 in the southern and eastern regions of

California. The CARE Study was a cross-sectional study that used a quota-sampling approach, where the quotas applied were based on gender, race/ethnicity, and subgeographic areas in order to best represent specific regions in California.

The CARE Study measured 12 PFASs in serum in addition to other contaminants and also asked participants to respond to an exposure questionnaire covering topics such as demographics, reproductive history, diet, home characteristics, occupation, and hobbies.

[SLIDE CHANGE]

TOKI FILLMAN: The CARE Study was carried out regionally, so samples for CARE-LA were collected in 2018 and cover Los Angeles County, and included 430 participants. CARE-2 covered seven southern and eastern counties in California. It was carried out in 2019 and included 359 participants. And CARE-3 covered Orange and San Diego counties. It was started in 2020 but had to be stopped early due to the pandemic, and so only included 90 participants.

[SLIDE CHANGE]

TOKI FILLMAN: For levels of PFASs in drinking water, we used data from the California Water Board's PFAS Monitoring Program. So as you can see in this very rough timeline here, between 2019 and 2022, the California Water

Board carried out three phases of PFAS monitoring with investigative orders sent to water systems. These investigative orders focused on areas with known or suspected PFAS contamination, such as areas near or surrounding airports, landfills, military facilities, as well as water systems that had previous PFAS detections from EPA's UCMR 3 monitoring, or the Unregulated Contaminant Monitoring Rule 3, which was the 2013 to 2015 version of EPA's required monitoring of unregulated contaminants in drinking water.

One challenge of working with this data source is that most of the sampling is from source wells as opposed to finished water. However, one benefit is that the statewide required reporting limits are fairly low. They're in the two to four nanogram per liter range, which is about 10 times lower than the MDLs that were used in UCMR 3's monitoring.

[SLIDE CHANGE]

TOKI FILLMAN: This slide shows the steps taken to match CARE biomonitoring participants to public water systems and thus drinking water data.

So first, all three of the CARE studies were combined together for a total of 872 participants. Then participant home addresses were geocoded in ArcGIS. Participants were matched to a single water system using

the shapefile provided by the California Water Board, the System Area Boundary Layer shapefile, a map of which you can see on the right here, that shows the water system boundaries throughout the state.

Then we limited to participants who were matched to water systems that were monitored during the 2019 to 2022 first three phases of investigative order period and then excluded participants who reported that their main source of water is a private well, as well as participants who were missing key variables, for a final data set of 563 participants.

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TOKI FILLMAN: To give you sense of who was in this study population, out of the 563 participants: their mean age was just under 50 years old; they were about 60 percent female; 40 percent reported their race/ethnicity as Hispanic; 36 percent white alone; and 60 percent reported having attended some college or trade school; and 20 percent reported having a graduate degree.

So in other words, compared to the underlying population, they were slightly older, more female, and more educated.

[SLIDE CHANGE]

TOKI FILLMAN: In the CARE studies there were 12 PFASs in serum measured, and in the drinking water data 18

PFASs were measured, and there was an overlap of 11 analytes between these two data sources, which will be the focus of the next few slides.

So this table here shows the detection frequencies and serum concentrations for those 11 analytes that overlap between CARE and the drinking water data. So as you can see here, PFHxS, PFOA, and PFOS had the highest detection frequencies, and were detected in nearly a hundred percent of our participants. And also these analytes had the highest serum concentrations in the 0.7 to two nanogram per liter range.

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TOKI FILLMAN: So to put these serum concentrations in context, this figure shows the overall CARE-LA and CARE-2 weighted serum concentrations compared to national levels from the nationally representative NHANES study. So you can see from this comparison that, in general, CARE PFAS concentrations are lower than national levels. CARE-3 wasn't included here, because CARE-3 was stopped early due to the pandemic and included so few participants. So CARE-3 data was not weighted. But if we do compare unweighted geometric means of CARE-3 with CARE-LA and CARE-2, they are in a similar range.

[SLIDE CHANGE]

TOKI FILLMAN: Next, getting into the drinking

water data, we found that 47 percent of the 563 participants lived in a water system service area with at least one detection. So in this map, you can see that in the background there are very light gray boundaries that represent water system service areas. And in the foreground, participants living in a water system with at least one detection out of those 11 analytes are shown in orange, and participants who live in a water system service area without detections are shown as yellow dots.

[SLIDE CHANGE]

TOKI FILLMAN: If we look at the same information by water system instead of by participant, the 563 participants were matched to 70 different water systems, 60 percent of which had at least one PFAS detection. And for context, I'm adding in the county boundaries as well. So in this map, you can see that water systems with at least one detection are shown in orange and water systems without detections are shown in yellow.

[SLIDE CHANGE]

TOKI FILLMAN: And if we look at the water systems with at least one detection by analyte, we can see from this table on the left here that PFBS, PFHxS, PFOA, and PFOS were detected the most among these 70 water systems.

[SLIDE CHANGE]

TOKI FILLMAN: So far we've looked at serum data and water data separately. So in both water and serum, PFHxS, PFOA, and PFOS had the highest detection frequencies. So these three PFASs were included in the final portion of our analysis to look at the association between drinking water and serum data. We also included a sum of the 11 PFAS number, which summarizes the 11 analytes that overlap between the two data sources.

[SLIDE CHANGE]

TOKI FILLMAN: Also, in order to look into the association between drinking water and serum, we needed to assign a drinking water exposure indicator measure for participants. So on this slide here, you can see a very simplified version of a water supply distribution system, where we have water from three groundwater wells flowing to a treatment plant before it's flowed -- flows to the distribution system and distributed to households.

So as a reminder, the California Water Board's PFAS monitoring is primarily from source wells for those first three rounds of investigative orders as opposed to finished water. And even among source wells, as you can see displayed here, not all wells in a water system were always tested. So when we started out this project, we had hoped to be able to take the level of PFASs measured in the source wells and then estimate or calculate the

final PFAS concentrations that are delivered to households.

[SLIDE CHANGE]

TOKI FILLMAN: However, actual water supply distribution systems are very complex and some may be even more complex than the complex diagram you see here. And so there are many challenges that make estimating PFAS levels in finished water difficult. So for one, again, the sampling is primarily from raw sources and not finished water. We also do not have sufficient information on water blending, mixing, or volume data, and the data collected is not consistent between water systems. Therefore, after working with our Water Board colleagues and looking into the available data, we concluded that we could not accurately estimate PFAS concentrations in finished water.

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TOKI FILLMAN: So given these challenges and the data we do have, we decided that the best we could do is to assign crude categories, which were based off of PFAS detections using statewide required reporting limits. So water systems were categorized into a binary category into those with no PFAS detections and those with at least one PFAS detection. And we did this categorization individually for PFHxS, PFOA, PFOS, as well as the sum of

the 11 PFAS.

[SLIDE CHANGE]

TOKI FILLMAN: For our statistical analyses, we log-transformed the serum concentrations and we assessed the associations between each of the binary PFAS detection categories and serum PFASs using multi-variable linear regression where the covariates included were age, sex, parity, race/ethnicity, education, income and nativity.

[SLIDE CHANGE]

TOKI FILLMAN: Now, getting into some of our results looking into the association between drinking water and serum. This figure here shows the adjusted percent change in serum PFASs when we compare participants who live in a water system with at least one detection to participants living in a water system without detections. So if we start by just looking at the results for PFHxS, we can see from this figure that participants living in a water system with at least 1 PFHxS detection had 32 percent higher serum levels compared to participants who were matched to water systems that did not have PFHxS detections.

[SLIDE CHANGE]

TOKI FILLMAN: And if we also take a look at the results for PFOA, PFOS, and the sum of the 11 PFAS, we can see here that we did not see significant differences in

participant serum levels when we compare participants who live in water systems with detections to participants who live in water systems without detections for these other analytes.

We are also currently working on different ways to analyze the data, but we are still in the process of evaluating those results.

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TOKI FILLMAN: In summary, what this means is that in this general population of adults in Southern California, PFHxS contamination in drinking water may be a significant contributor to serum levels, even in a community without high level of contamination due to industrial manufacturing. And in general, this is consistent with literature published so far on drinking water contributions to PFAS.

[SLIDE CHANGE]

TOKI FILLMAN: The results of this study as well as other similar studies will be helpful in the development of health protective drinking water levels, and are also particularly relevant given that the EPA is expected to finalize their national contaminant levels -- I'm sorry, maximum contaminant levels very soon.

Addressing PFAS in drinking water can be expensive and can be resource intensive, so these results

as well as other similar study results will help support enforcement of these MCLs.

[SLIDE CHANGE]

TOKI FILLMAN: Finally, I would like to acknowledge that this work was only possible because of strong collaborations between Biomonitoring California and the California Water Boards. Drinking water data can be very challenging to interpret, so our colleagues Scott Coffin and Brandon Ta were instrumental in helping us work through this data. I would like to also acknowledge Nerissa Wu and especially Kathleen Attfield for their supervision and guidance, as well as the CARE participants, CARE study team, the California Water Board SABL team, OEHHA, and DTSC.

[SLIDE CHANGE]

TOKI FILLMAN: And that's all I have. Thank you.

CHAIR SCHWARZMAN: Thank you, Toki. And we'll do questions for all three of these first speakers together, once we hear from our final speaker.

I want to introduce Wendy Linck, Senior environment -- Engineering Geologist in the Division of Water Quality at the State Water Resources Control Board, also called the State Water Board. She's managing the State Water Board's response to the PFAS effort in the Division of Water Quality.

Wendy graduated with a Bachelor of Science Degree in Geology from Sacramento State University. She's a Registered Professional Geologist in the State of California and certified as a Project Manager Professional by the Project Management Institute. Today, she'll give an update of the California Water Board's PFAS testing of drinking water and other potential sources.

(Thereupon a slide presentation).

WENDY LINCK: Well, good afternoon. I hope everybody can hear me and see me. I'm actually zooming here in Sacramento and I appreciate your time and appreciate you inviting me. I'm going to follow up with a little bit more information.

Toki gave a great summary of kind of what's going on in regards to what the PFAS testing results are going on along with the -- at the State Water Board. And so the State Water Board, both the Division of Drink Water, and I sit within the Division of Water Quality, we have been coordinating efforts in regards to understanding where the presence or absence of per- and polyfluoroalkyl substances are in the state statewide since about 2018. And we've been -- there's been significant effort in understanding the occurrences of both in drinking water, but also at those industrial source areas that Toki was talking about.

And so I just want to take a quick moment to

acknowledge Dan Newton, he's the Assistant Deputy Director at the Division of Drinking Water. He's been instrumental as a leader in this effort and he'll have his contact informations at the end of the slide show. This presentation is going to provide a perspective on the number of per- and polyfluoroalkyl substances that we can evaluate using current analytical testing methods in comparison to the known lists of PFAS. But I'm also going to summarize some of the statewide investigative efforts so far. I'm going to show you where all that data, at least on a slide that Toki pulled from in some cases, and describe some very exciting efforts that we're going to start very soon in regards to understanding not just those PFAS that we can see and targeted methods, but hopefully maybe the entire class of PFAS that we can see in the drinking water supply statewide.

[SLIDE CHANGE]

WENDY LINCK: So we just want -- we have this slide. We wanted to really just ground ourselves in regards to -- in our -- and think all of us understand that PFAS is a very large class of compounds. There are thousands of them being used in commerce and industrial applications. And currently, EPA's master list is around 14,000 chemicals or structures.

At those numbers, it's going to be very difficult

for us to identify all PFAS individually. Currently, analytical toolbox includes targeted analytical testing methods and not-targeted analysis. Using targeted testing methods, the number of analytes that can be qualify -- can quantified against known PFAS compounds standards are about 40. There are some labs out there that are now breaking into about 70 PFAS. But in the drinking water realm, there are, by using EPA methods, 533, that's only 25 analytes. In the water quality side, we've been utilizing in the brand new method that's available out there is 1633, that gives you 40.

And so we really need to understand more than that. The latest research using non-targeted analysis is expanding our ability to identify those using their structural identity. So our statewide investigative efforts are focused on using targeted testing methods to understand the presence or absence of PFAS that are known and most known in most studies. But we're now moving in a very exciting direction to get an understanding of the rest of the PFAS that may be known using non-targeted analysis in combination with targeted testing. So in order to get that ability, we've been coordinating with the U.S. EPA Office of Research and Development over the past year.

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WENDY LINCK: This -- we're going to talk about -- little bit about the data that we've found both in the drinking water side and the industrial source side and the water quality side. And so, our approach was to start issuing statewide investigative orders to gather information on the occurrence of PFAS in California's drinking water sources and at the those suspected industrial source sites.

We identified those industries where we knew that -- where the highest impact would be and could be found in drinking water and in groundwater. So as such, the investigative orders were issued to airports, chrome plating facilities, bulk field terminals, and refineries.

We also issued orders to those secondary receivers of PFAS-containing wastes, and that includes municipal waste landfills and wastewater treatment plants. The Water Boards are focusing on determining the extent of those impacts by sources. So this map shows the locations of all those orders that have been issued.

In coordination with the issuance of those investigative orders to the industrial source sites, Division of Drinking Water asked public systems -- public water systems to sample their wells, their source wells, located adjacent to those sites and in the vicinity of the military.

Most recently and excitingly about a week ago, the Division of Drinking Water issued a new order to public water systems that serve disadvantaged communities statewide. This 2024 order has a specific purpose to understand the class of PFAS in the water supply. This sampling will be performed at no cost to the water system. It is being funded by the State and I'll provide a little bit more details coming up.

[SLIDE CHANGE]

WENDY LINCK: So the GeoTracker PFAS Map is a really important tool for us to provide public transparency. It was borne from the need and the importance to be transparent with all this data and it's used to view data trends, and locations, and provides geospatial relationships. It is one of -- very unique map. It includes all the water quality data as well as the data from the Division of Drinking Water as well.

Between the divisions of Drinking Water and Water Quality, we have over 10,000 samples collected to date in this system. And with the most recent order that was issued by the Division of Drinking Water, we have over 3,000 investigative orders that have been issued.

[SLIDE CHANGE]

WENDY LINCK: This graph illustrates the occurrence of PFAS in a variety of source locations based

on a range of concentrations and percent detections. Percent detection is on the Y axis, the industrial source investigations, and the public water system sampling are along the X axis. Data includes groundwater along with wastewater treatment plant effluent.

The broadest range and highest concentrations of PFAS detected is found at airports, terminals, refineries, and that is because and that due to the presence of what is called an aqueous film-forming foam, or AFFF. It is used in fire training exercises and emergency response actions.

Next, are the chrome platers and their universal use of what they have is a PFAS-containing mist suppressant that is used during chrome plating operations. However, it's not used in nearly the volume -- the amount that AFFF, the aqueous film-forming form, is used.

The other sites, the landfills, wastewater treatment plants effluent, and groundwater have very similar characteristics being that they are secondary receivers of PFAS. Public water system wells that are on the far right and have concentrations with percent detects like those of the industrial source sites like the landfills. The locations of these wells was intended to be in the vicinity of those source investigation sites.

[SLIDE CHANGE]

WENDY LINCK: So this will be the last graph I'm going to show. And this graph represents what we collectively did in February, as we downloaded all the data -- all the data from the PFAS mapping tool and calculated the median concentrations for the PFAS that are listed along the X axis. They represent groundwater samples as well as from those source drinking water supply wells. The drinking water supply wells is the blue line, the airports, the bulk fuel terminals and refineries are in the dark orange lines, landfills and chrome platers, and at the wastewater treatment plants are kind of in that lighter coral. And N indicates the number of samples of each of the sites.

So the X axis shows the PFAS analytes. The Y is the log scale meaning concentrations in nanograms per liter. And what you want to see in the first couple of things that first come out in regards to this is that you have definitely a separation between the median concentrations that are at the airport and bulk fuel terminal refineries from everybody else. That is, once again, because the use of the AFFF, the aqueous film-forming foam, is used -- concentrated at the surface and is impacting groundwater. We have some locations at those efforts that have much higher concentrations that are shown by these medians.

And below that, you have the rest, the wastewater treatment plants, and the chrome platers, and the landfill and their ground water. The other thing that you can clearly notice is that whatever analyte that we say, based upon targeted results, we get the same shape. We see the same line. We see the same occurrence. So it doesn't matter where you are at a public water system, or you're at an airport, or you're at whatever, we pretty much see the same analytes based upon the targeted list.

If you were to compare that to where the proposed number for PFOA and PFOS that's at awe 4 nanograms per liter, that kind of gives you an idea in regards to semi-quantitative magnitude in relation to the public water system wells. Obviously, there are areas in the public water system, both at the source areas and at the industrial sites that are much higher than this. But overall, it kind of gives you an idea of what we're seeing in -- yeah, out there in the water quality and the water -- in the source wells.

[SLIDE CHANGE]

WENDY LINCK: So this is a map. This is resultant data from the sampling of the public drinking water supply wells for PFAS. It represents data that is as of the fourth quarter 2023. And this is where -- this is resultant data for the public water system wells at the

source. And these show three different levels. They are called advisory levels, Division of Drinking Water issues them in order to help the water system to have to deal with what result that they might get in regards to testing those wells as a result of those orders that were issued to them.

So you have whether there is an exceedance, that's in green. Yellow, if it exceeds a notification level, which means that they have to notify their governing board and body that they have an exceedance above a certain level, and the response level. And the response level means that public water system has to either, one, remove that well offline, two, either treat maybe through blending to reduce those concentrations, or three, provide a public notification to all their customers.

And there are currently four notification and response levels issued by the Division of Drinking Water. There are PFOA, PFOS, PFHxS, and Gen -- and PFBS. And PFBS we don't see in high -- very high concentrations in the state of California or let alone in the drinking water. And so that red square means that there is an exceedance of one of either one of those three PFOA, PFHxS, or PFOS in the state of California.

[SLIDE CHANGE]

WENDY LINCK: So in 2021, the State Water Board, we collected samples from about nine water wells across the state in 2021. Samples were tested by available and conventional targeted analytical methods and a method called adsorbable organic fluorine, using it similar to a proxy to total PFAS. This figure to the right depicts the results from one of those sampled wells. The sum of the PFAS reported using conventional test methods did not add up to the amount that you can see using the total PFOS or AOF method, and that's represented by that blue bar.

In some cases, only up to 70 percent was not accounted for by targeted and analytical methods in our public drinking water supply wells. This discrepancy triggered the need to understand what is contributing to that unknown mass, what are they, are they being removed by treatment. And finding answers to these questions led to several events.

One, we've been working with the U.S. EPA Office of Research Development, as I mentioned before, the leading experts in the areas of PFAS investigation, data analysis, laboratory analysis, and specifically non-targeted analysis; and two, working with environmental justice groups to advocate for the inclusion of funding in the most recent budget that totaled about $15 million.

[SLIDE CHANGE]

WENDY LINCK: So in AB 178 the Division of Drinking Water, using those funds, are now tasked to: one, develop a broad spectrum test method; two, monitor public water supply wells serving disadvantage communities, within the state - there's approximately 4,000 of those; and three, develop a treatment-based regulation for PFAS as a class.

Task number one is nearly complete. We have our half, and have selected AOF as our broad spectrum test method that we're going to move forward on. Task two has been -- has begun by the issuance of that 2024 order. And sampling is planned to start in the spring.

We've issued a contract to a commercial laboratory to do the analytical testing. Sacramento State University will provide technical assistance for sampling services and outreach materials of the public water systems being sampled. The locations of these wells to be tested across the state are shown on the map to the left. Data from this effort will provide incredible information on the estimate of the total mass PFAS, as best as it can be estimated, but also the PFAS that are not on the targeted analytical tests, those unknowns.

We anticipate that results from the sampling will likely indicate similar mixtures of PFAS in several geographic areas and regions, and likely list the PFASs

that are common or are not common in those regions. Based on analytical testing results and any exceedances to drinking water advisory levels, financial assistance will be available for public water systems to determine the next steps for treatment. This project is projected to take approximately five years to complete and the well sampling will be completed by the end of 2026 and hopefully my voice is going to last. Okay.

[SLIDE CHANGE]

WENDY LINCK: So thank you for your time. And if you've got any more questions, I'm more than happy to be here to help out.

Thank you.

CHAIR SCHWARZMAN: Thanks so much for that.

What we're going to do now is have 10 minutes where we can do sort of follow-up questions from all three presentations that just came before and then we'll also have a public comment period in there and then we have sort of a less structured discussion time. So the -- initially these questions should be sort of clarification questions for the speakers and then we'll have a larger discussion. So questions from the panelists.

Yes, Tom.

PANEL MEMBER McKONE: There we go. My question is from the first presentation, Nerissa, on the ACE Study.

So I was curious if there's any parallel or complementary effort to actually look at the food types that people were eating, right? I mean, you were looking at Asian community and seafood as a strong seafood diet, but was there any specific sampling of the food they were eating?

DR. NERISSA WU: We did not have complementary fish sampling to go with the study, but we are -- and Kelly Chen is here who can talk a little bit more about this. We are doing a lot of comparison to what fish data does exist for PFASs to go back and try to do a similar analyses that you've just heard about for drinking water. One of the things we're finding is that there just is not a lot of fish data out there. PFAS are very hard to -- it's obviously very expensive to do a PFAS measurement. And particularly for whole fish measurement, there is some data for filet. There's less data for other parts or whole parts of the fish. So one of the things that the work has highlighted is the need to do more sampling.

PANEL MEMBER McKONE: Can I -- while I'm here, can I ask another question for Toki?

So on the -- on the drinking water study, I really agree with your approach in having -- we tried this thing -- you know, blending. And figured that water is too complicated to blend, but there's another issue that

confounds this, and that is knowing how much water people actually drink from their tap. And to begin with, we actually -- you know, it's 2 liters, but -- on average that -- of fluid that people consume, but it's all over the map even there. But then when you get that down to much of that comes out of the tap. And I was just wondering if there's anyway to sort of further consider the types of people who would be drinking more bottled water, who wouldn't be using water as much to boil food. There's a number of things that might actually narrow some of the variability on that question.

TOKI FILLMAN: Yes. So unfortunately for the CARE Studies, we don't have information on the amount of water that people drink, for example, in a day. But the CARE exposure questionnaire does have a question about whether participants get most of their water from tap water versus bottled water and we have started to look into some of those results. And so about 40 percent of our CARE participants do report mainly getting their water from bottled water. So one of -- one of the ways we're starting to look at the data, but we're still in the process of analyzing is taking the main analysis results that I showed for -- to you today, but then stratifying the analysis by participants who report that they get their water from tap water and those who do not report

getting -- mainly getting their water from tap.

And when we -- when we stratify these results, just to give you a little sneak peek, we do see stronger associations for PFHxS among participants who get -- report getting their water from tap water as opposed to bottle water, providing some suggestive evidence that this association is from tap water.

CHAIR SCHWARZMAN: Yes, Carl.

PANEL MEMBER CRANOR: Kind of follow-up to Tom's question. He asked about food as a source and you're studying water as a source. Are those -- is water the easiest one to study? How about air tox -- air exposures? That might be a very difficult, but I'm just -- to get the big -- the big exposure picture out here, I'm wondering about other sources.

TOKI FILLMAN: Yes, that's a great question. I'm not sure if water is the easiest, because water is complex in its own ways and so is diet. For this particular study, we really focused on water and we didn't include diet, but we do -- we have been working with collaborators over at Boston University who are using these CARE Study participants as well by looking at contributions of both diet and drinking water on serum levels.

And for their study, they're using UCMR 3 data instead of the California Water Board's drinking water

data, but then also diet from the CARE exposure questionnaire. And they have found that there are very small effects or no effects from diet on serum when they -- in the data that they looked at. So in relation to the analytes that I focused on here, they have found that no associations between diet and serum for PFOA and PFHxS, and then small effects for PFOS.

PANEL MEMBER CRANOR: Any evidence on air, that's really hard?

TOKI FILLMAN: We unfortunately don't have data on air, so --

DR. NERISSA WU: I'll add something to that. We do have the addresses where CARE participants lived at the time of the study, so we haven't done this yet, but we could look at proximity to sources, if they are -- if we have a large enough in to see if there's any association between, you know, suspect sources and the participant levels.

PANEL MEMBER LUDERER: This is a related question. I think you might have already answered this, but I was wondering whether you had a chance to look at the CARE participants, you know, to try to look at both the dietary, the fish consumption, and the water exposure together, you know, to analyze that in the same analysis and see which one was more predictive.

TOKI FILLMAN: Right. So that's actually the analysis that our collaborators over at Boston University have carried out. So they've included both diet and drinking water in the same analysis and have found little to no relationships for diet, but they have found drinking water relations between drinking water and serum.

PANEL MEMBER LUDERER: And are you planning on doing that for the CARE Study, hopefully?

TOKI FILLMAN: Great question. We weren't -- we aren't necessarily planning on doing it, especially because the effects for diet were so much smaller than expected.

DR. NERISSA WU: And the Boston University is with the CARE participants also.

PANEL MEMBER LUDERER: Oh, it is.

DR. NERISSA WU: Yes.

PANEL MEMBER LUDERER: Okay. All right.

DR. NERISSA WU: Yes. Sorry, the CARE participants are the subject -- are part of that analysis. The Boston University -- the difference is that they're using the UCMR 3 data as opposed to the Water Board data.

CHAIR SCHWARZMAN: Any other clarifying questions for our speakers?

DR. NERISSA WU: Could I just add a clarif --

CHAIR SCHWARZMAN: Please.

DR. NERISSA WU: -- Correction rather. When I talked about MAMAS, I referred PFBS as the -- as the analyte that going up, but it's actually PFBA.

CHAIR SCHWARZMAN: I think the slides were right. Yeah, the slides were right. Great.

Yes. Question in the back or from the web.

REBECCA BELLOSO: Yes. We have a question from an anonymous attendee for Toki. It says, "I'm not familiar with municipal water systems. How different are adjacent water systems in the areas you looked at? Do they get water from completely different sources or do they just go through different treatment plants?"

TOKI FILLMAN: That's a great question. And it's possible that Wendy may have some ways to contribute to answering this question, but I can say that the water systems included in the CARE Study that I showed today are primarily large water systems that serve at least 10,000 people, because of the fact that CARE participants are -- tend to be in more urban areas than rural areas and water systems can also purchase their water from adjacent systems and sometimes share treatment plants as well, but I wonder if Wendy has anything to contribute to this answer.

WENDY LINCK: That was a perfect answer, Toki. You got it. It's all of the above. That's why it becomes

so complicated with the water systems in the state of California and the flow of water. And it can change with which wells they can turn on and turn off, and based upon time of the year, so -- and I just wanted to add just one thing, there could be a potential -- a potential idea to use in the future maybe, Toki and other. The UCMR 5 data is all data that's being collected at the distribution point, and that includes 29 PFAS. And that data is being -- is being collected as we speak and already starting to be published. So there could be an opportunity to maybe update your assessment in the future.

TOKI FILLMAN: Thank you, Wendy. Yes, we are interested in taking a look at this data as well.

DR. JENNIFER MANN: I think that may have just answered my question, which was about finished water. And I realize there might be challenges in measuring that. But it would be really interesting to look at finished water near some of these sources just to know maybe how well these PFOS are removed.

CHAIR SCHWARZMAN: Can you just identify yourself for the transcriber, please.

DR. JENNIFER MANN: Oh, Jennifer Mann.

TOKI FILLMAN: Thank you, Jennifer, for this comment. I think that's a great idea, and, yes, something that we're interested in is being able to compare the

finished water to the data we're looking at that's primarily from source wells, especially as the UCMR 5 data is coming out.

DR. JENNIFER MANN: And from the Water Board's perspective --

CHAIR SCHWARZMAN: Jennifer, I'm so sorry. Can you use the microphone for the transcriber?

DR. JENNIFER MANN: Sorry. I keep messing up. So my question was more for Wendy on what challenges may exist in being able to analyze that -- those source -- the finished water. Yeah.

WENDY LINCK: So we're going to sample water at the wells. That's going to be first. So we're going to sample all those wells over the next two years. But that third objective that we are -- will undertake is more understanding the treatment side what does -- and the different available treatment technologies that are available in the state of California and how they remove -- what is the removal of PFAS not just for the targeted analytes but for the either the total amount or a proxy of the total amount, and those non-targeted analytes. So we will know what's passing through, which I think will be an important thing in regards to understanding any health impact. That doesn't mean that an entire -- all of those analytes are a problem, but we

just want to know what they are. So hopefully, I answered the question, so we're focused still at the source wells.

CHAIR SCHWARZMAN: Rebecca, was there another web question?

Great. José. Thanks.

PANEL MEMBER SUÁREZ: Great. Thank you. This question is for Wendy. Perhaps, you could share slide number 8 one more time. I just want to get a clarification question here. This is about the differences between the organofluorine -- the total organofluorine content versus the targeted analyses for the PFAS. Perfect.

There. So a couple of things, right? So this is pretty troubling if the -- if what you're saying there is up to 70 percent of reported sums of the targeted PFAS were not accounted for from the total PFAS concentrations there. For my clarification here, so the different colors there, the green, the yellow, the orange --

WENDY LINK: Um-hmm.

PANEL MEMBER SUÁREZ: -- those are targeted analyses and those are total sums from different measurements, is that what it is?

WENDY LINCK: Yeah. Those are total. So we use 533, that's actually in orange. So we summed them all up. Essentially, you can convert them into organofluorine,

nanograms of fluorine per liter. You add them all up. And so 533 is orange. Yellow is 537.1. We did another -- a different analysis, the total are oxidizable precursor. That's this TOP assay. That's in green. And then actually in gray is a different kind of method that's performed by the Department of Defense through the Quality Systems Manual. But the drinking water methods are the ones that are orange and yellow.

PANEL MEMBER SUÁREZ: Okay. Thank you for that. I mean, it's pretty shocking. It looks like we are not really capturing everything that we should be capturing.

WENDY LINCK: That's correct.

PANEL MEMBER SUÁREZ: Any thoughts about this? Is there something big that we're missing that you can think of?

WENDY LINCK: Yep. Yep. And our method, because we did a method comparison study just a few months ago. We went back to the same nine wells that we did here and we performed non-targeted analysis and did some selective analyses for ultra-shorts. Ultra-shorts are the C2s and C3s. They're a small -- much smaller molecule -- analyte. And so we're finding out that we're seeing quite a bit of those ultra-shorts in our -- in drinking water, so -- and the -- yeah. So there's more organofluorine in the drinking water and most likely in groundwater. They're

just not on the targeted analyte list.

PANEL MEMBER SUÁREZ: And for those, do you have an idea of what mostly they're used by industry?

WENDY LINCK: Well, it depends on what you're talking about. There's a lot of -- in the PFAS world, you talk about precursors. And I don't know if folks are familiar with that terminology, and there are the newer formulations that are out there. Those ones that are on the targeted list are those sulfonates and carboxylates that are -- actually are terminal end products, where these other analytes can transform into. And so those are the ones that are on those targeted lists. But there are a lot of other newer formulations of PFASs that are being used at industrial sites. And one of them is at -- use the aqueous film-forming foam. And so they are the four telomers. And those would be picked up in the blue bar that are not being represented currently in the other bars. So that's a -- that's a gap. There's a gap there.

PANEL MEMBER SUÁREZ: Yeah, I mean, this is -- this is very provocative in some ways, right? It's only nine --

WENDY LINCK: Um-hmm.

PANEL MEMBER SUÁREZ: -- drinking water supply wells sampled. Nonetheless, it still provides a lot of insight into this. Any plans on expanding this?

WENDY LINCK: Yeah. So this is that whole exciting study that we'll start this spring. Those 4,000 wells across the state. We're going to be analyzing, like getting that blue bar again. We're going to have the total for the 533, the blue bar, but we're also going to do non-targeted analysis, which means we will know -- we will know what those compounds are that's making up that blue bar. We won't know the concentrations, but we're going to know what they are. And I think that's the first step of really understanding what's in our drinking water supply and what's in our groundwater, and then we can move forward, right? We can move forward and figure out what the health impacts are for those -- for those analytes.

PANEL MEMBER SUÁREZ: Thank you.

WENDY LINCK: You're welcome.

DR. NERISSA WU: Stephanie, did you want me to wait before my comment?

Okay. The data is obviously very compelling to us as well. We're very interested to know how our biological samples would compare if we did similar analyses. So for STEPS, we are in conversations to identify additional methods that we could apply to the STEPS samples to magnify our understanding of not just PFASs or the expanded list that we can measure, but that non-targeted -- the ultra-short chains and try to figure

out what's happening, you know, what's the exposure for all these unidentified PFASs.

CHAIR SCHWARZMAN: Let me take a moment to call for public comment, which we need to do in this interval. Rebecca for -- so first of all, if there is anybody in the room who would like to make a public comment at this time or if there's anything that's online, and then we'll continue the discussion.

So have an in-the-room comment.

NANCY BUERMEYER: Hey, everybody. Nancy Buermeyer, Breast Cancer Prevention Partners. And I just want to say thank you to the pro -- to the Biomonitoring Program for this data and to the State Water Board. This is exactly the evidence we need as advocates to do our work. The State has acted to ban PFAS in firefighting foams, in food packaging, in textiles, and a couple of other juvenile products. And there's a bill this year that would ban all but essential uses of PFAS. There have been studies that have shown over 200 different use categories for these chemicals.

And this legislation that's pending, and it's authored by Senator Skinner, who represents this part of the world and it's sponsored by NRDC, Environmental Working Group, Clean Water Action, our -- BCPP, my organization, and the California Association of Sanitation

Agencies, CASA. Those are the people who have to treat the water. And they're all about getting it out before it gets into the water, which is why they are actively working on this legislation. But that blue bar that you talked about is exactly the reason advocates have asked that this method be developed, because we know there are so many different types of PFAS out there. It has to be regulated as a class and we have to be able to look at total organic fluorine so we know where we are in our efforts to try to clean up both the water and ultimately the contamination of the rest of the environment and ourselves. So this data is super helpful, super useful, and we will use it to try to pass this legislation SB 903 this year.

CHAIR SCHWARZMAN: Rebecca, is there anything online that we should tend to?

REBECCA BELLOSO: No.

CHAIR SCHWARZMAN: No. Okay. Then we can resume our discussion. I think Tom had something.

PANEL MEMBER McKONE: Yes. Thanks. This is in the realm of a discussion point and something, you know, that I think our Committee has to think about in terms of where we're going. Is there any sense of the time trend on total PFAS? Is it going up rapidly? Is it going up slowly? Is it stable? Is it dropping? I mean, are we

getting a sense of that or is there a way -- and again, I think it relates to our Committee, because when we pick a chemical class, we're doing it because usually it's on the rise and we're doing it to see when it quits rising hopefully, especially with new legislation.

So if there's an opportunity to not only look at like what we're seeing now, but a time trend, I think that would be very useful, particularly if the time trend is steep going up. And then the question is when is it going to peak and how do we -- how do we keep it -- how do we get it to slope and turn around as soon as possible.

DR. NERISSA WU: Well, the hope is in two to three years, we'll have STEPS data which provides temporal trend for the 42 that we're measuring with the existing -- with the existing method, but that's why we have set up the study in this way, so that -- and we have this -- and my previous comment about trying to get this overall mass balance of fluorine as well, because one thing we can understand from the targeted method is maybe we'll see these downward trends. We don't know what else is happening, whether there are changes in formulation, whether these other PFASs that are going up. So getting this full mass balance would really help us understand that.

CHAIR SCHWARZMAN: Yeah, just to add onto that, I

was -- there's -- like often we're seeing evidence, and I think this was in part of what Nerissa presented of generally over time PFAS levels declining, but I think that's -- like, we have to keep in mind that's the PFAS we know to measure, right? And so this -- the gap represented by the blue bar may really represent chemicals that are increasing steeply over time. So I think this data will be really interesting and it's an important point to keep in mind.

CHAIR SCHWARZMAN: Carl.

PANEL MEMBER CRANOR: I apologize for the question I'm about to ask, but may I see -- may we see just for a moment Toki Fillman's second slide. It's the exposure slide. Pathways.

Yeah, that one. I think that when I saw that, I was taken by what the dramatic picture it paints. Today, we're discussing various ways of trying to identify and clean up things that are potentially harmful to human beings. What I would like to just go on the record about is that something didn't happen before that factory threw all those things into the environment. They didn't understand their products. They didn't try. And there are legal incentives not to understand their products.

And so we're trying to identify messes and cleaning them up when we could have done something vastly

more preventive in advance. And we're not doing that -- this group I think will surely be sensitive to it, but we have to recognize the social and legal shortcomings that put us in this position. That's all I have to say.

And I apologize, it's slightly out of the game here, but we can't let this slide go unnoticed.

PANEL MEMBER LUDERER: I just have a more technical question to get back to it. Although, I wholeheartedly agree. And that is you were talking about the STEPS study, you know, and how that's going to be able to give time trends. Are you -- is it possible for you to go back into those samples to measure the total, you know, organic fluorine so that you can look at the trend of that as well?

DR. NERISSA WU: That's the hope. There's very small volume for these samples, so that's part of the conversation we're having, how much sample do we need. Is -- would pooling be a valid way to look at the samples. These are samples for which we don't do results return, so they're a little easier to do some of these more researchy methods. And so I don't know, Kathleen, if you want to address it. Some of it is also look at the commercial availability of some of these for large-scale studies to do either ultra-short or the EOF, the extractable organic fluorine method, and which one of us -- which one of those

methods is going to give us the most thorough understanding. They all have their challenges. They all have their limitations. So that's our challenge right now is to figure out which path to take?

CHAIR SCHWARZMAN: Oliver, and then Amy, and then we have a five minute break scheduled so --

PANEL MEMBER FIEHN: Okay. I'm also sorry for my question, but I'm also having a technical one and that goes to Wendy Linck. So I understand that you have chosen the extractable organic fraction and not the adsorbable organic fraction of the non-targeted approach for the PFAS. And what are the costs for that?

So is it like very cost effective compared to other methods, the targeted for example, A, and B, can these used for other matrices specifically for plasma or serum?

WENDY LINCK: So we have selected adsorbable organic fluorine AOF, not EOF, and -- and maybe I may have stumbled over that word earlier. Apologies there. AOF is a lot more cost effective than the targeted analysis, because you're only doing one analyte, right? So you're a couple of hundred dollars or a little bit more, whereas 533 is -- could be twice as much in cost for the targeted analytes approach. And you had a third question, I'm sorry. What was that?

PANEL MEMBER FIEHN: Can It -- whoops. Can it be used for other matrices like blood?

WENDY LINCK: I don't know. That would be a good question. That would be a good -- I am not sure. I'm not sure about --

PANEL MEMBER FIEHN: Okay.

WENDY LINCK: -- about that, how that would -- how that would work. So I would need to -- I don't know the answer to that.

PANEL MEMBER FIEHN: Okay. Thanks.

PANEL MEMBER PADULA: I have a question that kind of piggybacks on that, because I was also curious, I know we always want more data in all these different dimensions, but to what extent do -- measuring total fluorine in both blood and in water might be more kind of cost effective to get sort of more numbers and then have more targeted studies to, you know, get into the specific analytes, because I -- when I saw the data on the PFHxS, this -- that that stood out -- is that stood out, just because that was the only one that we had sort of the power to look at or is that just sort of the keys under the streetlight? So I think this kind of -- this really brings up the combination of the need to do both maybe.

CHAIR SCHWARZMAN: Great. Thank you, everyone, who presented. And all of these thoughts in follow-up.

We have a five-minute break now that we were supposed to start a minute ago, and I don't think we can shorten a five minute break. So let's come back. We'll start again at 2:31.

Thank you.

(Off record: 2:26 p.m.)

(Thereupon a recess was taken.)

(On record: 2:33 p.m.)

CHAIR SCHWARZMAN: Okay. We're going to get started again on our next agenda item. And we will be hearing from two speakers. The first is Jill Johnston, who received her PhD in Environmental Sciences and Engineering from the University of North Carolina at Chapel Hill and is currently an Associate Professor of Population and Public Health Sciences, and Director of the Environmental Justice Research Lab -- (clears throat) -- excuse me -- in the Division of Environmental Health at the University of Southern California. She conducts community-driven studies and exposure assessments to address inequitable exposures to harmful contaminants that affect health disparities including in Latinx, Black, and Asian Pacific Islander communities, and among the working poor. She has studied health impacts of oil production in Los Angeles and South Texas, and has served on technical advisory panels on health impacts of oil production for

the LA County Department of Public Health and the State of California. Today she'll be presenting on urban oil drilling, environmental justice, and community concerns.

(Thereupon a slide presentation).

DR. JILL JOHNSTON: Thank you very much and thank you for the invitation to be here today.

All right. Are my slides up?

PANEL MEMBER FIEHN: (Thumbs up).

DR. JILL JOHNSTON: Yep. Awesome.

Great. So I'm just going to share a broad overview, really focused around community concerns and ongoing research around upstream oil and gas extraction with a focus on Los Angeles County.

[SLIDE CHANGE]

DR. JILL JOHNSTON: So I have no conflicts to disclose.

[SLIDE CHANGE]

DR. JILL JOHNSTON: So just bringing us back kind of over a century. There was a massive oil boom in Los Angeles. The oil was easy to access, close to the surface, and there was a rampant proliferation of wells that soon followed its discovery. The laws that governed both the ownership of land and oil in early 20th Century California really encouraged this dense rush drilling. And the results are really that this kind of industrial

development and extraction was intermingled with where people were living and where businesses were operating. And this really kind of exemplified a pattern of development where these industrial operations were occurring alongside where people were living.

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DR. JILL JOHNSTON: So today, there are over 20,000 active, idle or abandoned wells spread across the county of 10 million people. While only about 10 to 15 percent of these wells remain active today, LA is still one of the largest urban oil fields globally.

In addition to extraction, like this, comes along with a massive network of pipelines, refineries, and cars and trucks that burn fossil fuels daily. And largely, this industry was -- has been underregulated and there are very few requirements that have separated where this is occurring from where people are living.

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DR. JILL JOHNSTON: Instead, sort of in lieu of strong regulations and in response to some land use conflicts, really the response was voluntary efforts that intentionally tried to disguise the oil and gas operations that were happening in these urban areas. So what this looks like is the pictures here where oil wells were operating inside buildings in these Disney-like islands

just offshore, or integrated into parking lots and strip malls. And so this was really coined aesthetic mitigation technology or really it's just hidden in plain sight.

Another popular practice we see at these wells that tries to disguise its operation is the use of industrial masking odorants, so these are kind of perfume like compounds that try to mask other noxious smells, such as hydrogen sulfide. And the protections that we see at different communities really depends on who lives in that community by community.

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DR. JILL JOHNSTON: So about 15 years ago, there was a rapid increase in oil production, particularly in some wells in South LA in the La Cienega oil field. And this uptick in the production resulted in communities experiencing a lot of nose bleeds, malodors, headaches, wheezing, and it was that community organizing that finally realized that hidden behind this wall was 23 oil wells. This was a largely low-income predominantly Mexican and Central American community. And really kind of the health efforts around understanding the impacts of these oil wells started with this community. And illustrated here is just examples of them kind of using manikins to illustrate a lot of the experiences that were happening when this upswing in oil production was

happening.

This largely ignored by many regulatory agencies. And the community was really asked to provide stronger proof or scientific evidence that there was a connection between oil drilling and community health issues. Particularly in this community, the EPA came to visit this site in late 2013. Many of the inspectors got ill. And since then, this site has been idle, but there are several nearby in the neighborhoods that continue to operate.

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DR. JILL JOHNSTON: And so what we find in Los Angeles is really this on-match proximity to these oil drilling sites. Here, we kind of illustrate how close the nearest residential building is to an oil drilling site. And in the vast majority of cases, there's less than 500 meters that separate the operations. There's about 2,500 active and 2,500 idle wells that still are operating or could operate across the county. And the majority of these wells are concentrated in predominantly people of color communities. And so we know this sort of can amplify and compound many impacts faced by those communities.

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DR. JILL JOHNSTON: And so to understand more about the potential cumulative burden of and the impacts

of oil and gas drilling in LA County, we compared CalEnviroScreen scores to proximity to oil and gas wells. Here, we generated quintiles specifically for LA County. And with that, associated the proximity to oil wells or whether or not there was an oil well within one kilometer to the quintile of the CalEnviroScreen score. So in essence, we observed that there was about a 94 percent increase odds of being within 1 kilometer of a well among the highest quintile compared to the lowest quintile in LA County.

And when we looked at multivariate models, the proportion of Black residents and the higher quintiles of CES scores were also associated with significant odds of having an oil or gas nearby. And so with this, we can see that there is sort of several like environmental justice implications when we look at the locations of these operations in LA County.

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DR. JILL JOHNSTON: So in speaking to the community, they also bring up several cumulative burdens that they face from the existence of these wells. So for example, many people bring up not only odors, but also extensive truck traffic, damage to the roads. And this is in addition to being sort of near freeways, near truck corridors, as well as having less access to educational or

health care resources.

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DR. JILL JOHNSTON: And the health effects that are frequently brought up include these acute health symptoms, such as runny nose and nose bleeds, headache and dizziness, eyes, throat, and skin irritation, as well as adverse impacts to pregnancy outcome and increased wheezing and asthma.

Also, folks often talk about concerns related to carcinogens and the use of carcinogenic compounds at these sites. And as you can see with these two pictures in South LA, we see how close they are located to residential buildings and to schools.

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DR. JILL JOHNSTON: And so just to highlight a few of some key health impacts that we've seen when specifically looking at communities near these South LA drill sites, that we have found adverse impact to respiratory health as well as cardiovascular health among residents that live within one kilometer of two drill sites in South LA. So in this study specifically, we recruited almost a thousand people, in partnership with community-based organizations and community health workers, or promotoras, to complete a questionnaire, conducts barometry, as well as do blood pressure

measurements.

And so kind of high level overview, we found that proximity to oil drilling was significantly associated with lower lung function. And we saw the largest deficits among folks that lived both nearby, so about less than 200 meters, and downwind from the oil wells. And the impact we saw was similar to studies that found adverse impacts to living with someone who was a smoker. And we saw this impact across all age groups and as -- as well as among asthmatics and non-asthmatics affecting that we see harm across sort of multiple populations in these communities.

Similarly, we also found significant decreases in blood pressure as the distance from the site increased. So this is suggesting that we're also seeing adverse impacts to the cardiovascular system.

And this primary data that we collected from South LA really builds upon a much larger body of literature that shows increased risk of adverse birth defects, especially preterm birth, and respiratory outcomes in communities near upstream oil and gas drilling.

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DR. JILL JOHNSTON: And so in addition, we have done some community air monitoring using gas sensors in these same South LA neighborhoods. And there, we observed

higher methane concentrations near oil and gas sites, as well as spikes of non-methane hydrocarbons, especially when there's activity happening at the drill pad.

Additionally, we have observed a significant decrease in air pollution as wells go idle. So as wells stop producing, we see decreases in both methane and non-methane hydrocarbons, as well as if we look at specific chemicals, such as benzene and toluene.

When we look at a source apportionment analysis, we can observe that a natural gas drilling source when the well was active contributed about 25 percent to all the VOCs we observed in the neighborhood, and less than one percent once the well went idle. So this suggests that the drilling activity does matter for air quality, even in these communities that are near freeways and other sources of air pollution.

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DR. JILL JOHNSTON: And so finally, this is some very preliminary work that we've done among residents that live within one kilometer from active oil wells. And we measured toxic metal concentrations in toenails. So here, we've measured manganese, cadmium, lead, antimony, arsenic, and nickel, and mercury. And so this is kind of very early work with about 250 people. But with that, we use these similar source apportionment techniques and kind

of identify three distinct factors, one of them which may be associated with oil drilling. And that factor contains manganese and nickel levels. We're working kind of on the larger study with this, including people that are farther away from the drill site to kind of understand more of these potential associations.

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DR. JILL JOHNSTON: And so kind of with that, I'm happy to take questions and just want to acknowledge kind of the many folks that helped to make some of this work possible.

Thank you.

CHAIR SCHWARZMAN: Thank you. We have a few minutes for questions specific to this talk before we go on to the next one.

Sure.

NANCY BUERMEYER: Thank you very much, Dr. Johnston. My name is Nancy Buermeyer. I'm with the Breast Cancer Prevention Partners. And I've heard people talk about the perfumes that are pumped into the world around these wells. And we do a lot on fragrance and all of the toxic chemicals in fragrance. And I was curious if any of the air monitoring was able to focus specifically on those fumes or if there's a way to get a sample of those perfumes in particular to see if we could figure out

what's going on with those? But thank you overall for all the work you're doing. It's awesome.

DR. JILL JOHNSTON: Yeah. Thank you so much. I mean you bring up a huge issue we hear a lot from community residents. Our monitors are sort of these sensors, so they're not able to capture anything specifically about these odorants, but I'd be happy to talk to anyone that has ideas about how to do that. There's not a lot of permitting of this. So essentially the data we have comes from community members that have taken pictures of the trucks with their kind of IDs on it, so we can understand what chemicals are being used and we can look them up. But because it may change over time, I haven't thought of a good way to really try to better monitor for that, but I'd love to hear other folks' ideas.

SUSAN HURLEY: Susan Hurley from EHIB. Thank you for a really interesting talk. I was curious about that last slide where you presented those results about the metals and toenails. I don't know if we really have time to get into it today, but if you could just tell me a little bit more about that and how you figured out which particular metals were associated with the various sources.

DR. JILL JOHNSTON: Yeah. So we use non-negative matrix factorization to identify sort of groupings. And

that's sort of a unsupervised technique that looks at how these metals may cluster together among the participants we have. And then it's really relying on existing literature to try to identify where these metals may be coming from. And there has been particulate work among occupational oil clean-up workers that has also seen this nickel manganese mixture and used that as sort of an indicator, right, of high levels of exposure to oil workers.

Also, an analysis that's been done of PM filters near drill sites, they also see elevated levels of nickel and manganese. So it's still preliminary and sort of has helped generate hypothesis, but I think, you know, it's very exploratory at this point and is something we're continuing to work on.

DR. MARTHA SANDY: Hi. This is Martha Sandy with OEHHA. Thank you for your talk. I read your publication, your paper on these -- the toenail study, the first one. And it looks like you methods are -- I wonder if you could say a little more about the methods. It looks look you've washed the toenails clippings quite a bit, but I just -- it occurred to me is there -- do you have any information or data on after all that washing, are you pretty confident that any trace metals that might have been in nail polish for instance, they have not penetrated and

bound to the nail itself?

DR. JILL JOHNSTON: Yeah, so we asked the participant to remove nail polish before doing the clippings. That's just with these like wipes, so it may not completely remove it. This work is done by Brian Jackson at Dartmouth. So he's the expert on the laboratory methods. I do not do that. He's been doing this for a long time and so I think he uses state-of-the-art methods, but I think, you know, there's always potential for residual contamination or potentially, you know, from nail polish. I think we tried to clean it the best we can. But because, you know, a lot folks in this study, a lot of women frequently get pedicures, you know, it -- we're not -- there's potential for that to be there as well.

STEPHANIE JARMUL: Actually, I have a question. Stephanie Jarmul from OEHHA. Could you talk a little bit more about why you chose toenails. As a Biomonitoring Program, we're obviously very interested in many matrices and just -- if you could say a little bit more about that.

DR. JILL JOHNSTON: Yeah. So I would say a big part of it was convenience and also comfort of the community in providing samples and then also some limitations when COVID hit, right, of what was easier to collect and store. And so that was some of the initial

factors we decided to work on toenails, at first. We've had a lot of conversations to think about what we could measure with either urine or blood. And, you know, I'm really interested to learn more from others around what could potentially be a good biomarker that could connect it back to like this crude oil signal.

DR. DAVE EDWARDS: Thanks. This is Dave Edwards from OEHHA as well. Just to kind of follow up on Stephanie's question, I guess, did you consider hair? I've -- back when I -- before OEHHA, I was doing some research and we did sort of hair -- metals in hair analysis, and just sort of wondering if that's better or worse than toenails, just sort of question.

DR. JILL JOHNSTON: Yeah. My understanding is that toenails are sort of -- reflect a longer integration, so it's more about nine to 12 months, whereas, hair may be more recent and also can impacted by things like hair dye. And sometimes people don't -- even if it's in the back, don't want to cut their hair. But I know there's been work out of Canada near its natural gas fracking sites, and they have used hair as a biomarker looking at various metals as well. So I think it's something that can be explored more.

CHAIR SCHWARZMAN: Would you say something about how much the metals are what you're concerned about? That

is among all the large selection of toxics that are associated with these -- with oil and gas production, how big are the metals, how big a component is the metals and what other substances are you looking at?

DR. JILL JOHNSTON: Yeah. I mean, I would say largely the concerns are around VOCs, especially the more toxic ones, both in terms of what we've seen with air monitoring. And I think in at least the urban environment right, air may be a really important pathway about how kind of exposures are impacting people's health. The use of toenails and metals was just a little bit exploratory, something we were interested in and had been kind of working at in a couple other sites. But do I think it's like the ideal matrix or chemical to be looking at, like probably not. I just sort of wanted to -- since this was biomonitoring, sort of share it with this group to, you know, see some of the work that we've done, but I think VOCs are definitely more of a concern.

CHAIR SCHWARZMAN: Thank you so much for that presentation and for all of the work that you're doing. It was wonderful to hear about it.

Assuming, there aren't any other questions, it's time for us to move on and I want to introduce Yan Lin, who received his PhD from UCLA in 2019 with training in analytical chemistry biomarkers and biostatistics.

Currently, he's a post-doctoral associate at Duke University's Global Health Institute and is on track to become an Assistant Research Professor at Duke's Nicolas School of the Environment. His research builds on efforts to discover novel exposure biomarkers that are more sensitive and specific to emerging pollution sources, such as wildfires, smoke, and oil and gas activities, and identify key signaling pathways that mediate the health effects of air pollution and climate change.

Today, he'll be presenting on urinary metabolites of polycyclic aromatic hydrocarbon derivatives as exposure biomarkers of air pollution sources.

(Thereupon a slide presentation).

DR. YAN LIN: Thanks for the nice introduction. Let me share my screen first.

First, I want to say good afternoon to everyone and I am very happy to have this opportunity to share our recent finding about the source-specific exposure biomarker.

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DR. YAN LIN: First of all, I'd like to declare no conflict of interest associated with my research and specifically for this presentation.

[SLIDE CHANGE]

DR. YAN LIN: I want to first talk a little bit

about exposure biomarker. The definition among different biomarker, exposure biomarker referred to the amount of xenobiotic substance or its metabolites in biological system and samples. So from this definition, we can clearly see that exposure biomarker is good to assess exposure for single chemicals, which pose significant challenges for air pollution exposure assessment because air pollution in nature is a chemical mixture.

So before we really use biomarker for air pollution status, we really need to identify important chemicals that are sensitive to environ -- air pollution changes as well as can directly inform the health effects of air pollution.

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DR. YAN LIN: For this purpose, we specifically focus more about the polyaromatic hydrocarbons for a couple of reasons. First, PAH can -- their sources vary. Also, common pollution sources of air pollution like combustion sources of vehicle emission as well as no combustion sources like a lot of petrogenic sources.

On the other hand, PAH are also semi-volatile chemicals that can exist in both gas and particulate phase. So their atmospheric transportation is very similar to those of important particulate matters and also gas phase air pollutant like nitrogen dioxide.

More importantly, substantial evidence that derive from toxicological and epidemiologic studies has identified PAH as the major toxic components of air pollution mixture. So the exposure assessment of PAH has key toxic components of air pollution can directly inform its health effects.

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DR. YAN LIN: So for now, we have pretty good exposure biomarker. I call it traditional exposure biomarkers for PAH. That's a urinary hydroxylated PAH. For hydroxylated PAH, it quantify the total amount of unsubstituted PAH that derive from almost all the combustion sources. However, as we can see in this diagram, most regulatory policy and interventional actions many target at the source, or in other words emission of the pollution, so that any result deriving from a hydroxylated PAH can really directly inform information about the source of emission of the pollutant in the air quality -- in the air.

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DR. YAN LIN: So given this situation, we came up with the idea to develop source-specific exposure biomarkers that can direct link pollution sources to health effects. So if this biomarker become available, the findings from this biomarker can directly inform

regulatory policy or intervention that target at sources to mitigate the health effects.

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DR. YAN LIN: So our efforts to identify those biomarker has greatly benefit from our early works about the source apportionment of ambient air pollutant. In those work, we have conducted large field campaign in North China and quantified more than 50 PAH as well as some well recognized source tracers in particle matter samples and air samples. So based on the source apportionment result, we have identified several PAHs that are good tracers for specific sources. For example, we have shown that 2-methylphenanthrene are good tracers for petrogenic sources. Where we also identify other good tracers like 1-nitropyrene for diesel exhaust, 2-nitropyrene for secondary formation, and also some methylated PAHs retain as good markers for wildfire.

So because -- at -- even if we have -- although we have conduct research for all these different sources, into this presentation, I will specifically focus on these petrogenic sources given the general interest in gas and oil related emissions in this Panel.

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DR. YAN LIN: Our study leverage some natural contrast in the air pollution conditions at different

locations to validate markers. Here, we mainly talk about two mega-cities in the world, one is Los Angeles, one is Beijing. I hate to say this, but I think both cities are very famous for its severe air pollution. But as we can -- as shown in these slides, the nature of air pollution in those two cities are very different.

First, the level of air pollution is dramatically higher in Beijing as compared with Los Angeles as indicated by those ambient PM2.5 levels. There are at least a five-fold difference in the level of air pollution. On the other hand, the source of air pollution is also different between the two cities. In Beijing, almost all the pollution sources are combustion related like vehicle, coal burning, and biomass burning. Also, Los Angeles in addition to those substantial petro -- pyrogenic sources like vehicle emissions, there's also a lot of petrogenic sources, like oil and gas drilling. So those natural contrast in the air pollution exposure provide a perfect opportunity for us to identify exposure biomarkers.

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DR. YAN LIN: Our study is built upon a very unique cohort, which travels between to the two cities in the summer each year. At UCLA, there will be a summer exchange program between UCLA and Peking University in

Beijing in which around 10 to 15 students from UCLA will travel to Beijing and stay there for 10 weeks.

So what we did is we tried to recruit student and collect their urine samples before, during, and after their travel to Beijing. We conducted the study for multiple years, so that we can also study the temporal trend of exposure over years.

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DR. YAN LIN: This figure shows the level ambient PM2.5 during the study period. In this pan -- each panel indicated the data in each year, and the gray dot here indicated data in Beijing, while the white dot indicated data in Los Angeles.

As we can see across different years, the level of PM2.5 is consistently higher in Beijing. Well, if we look into those green dots only, the level of PM2.5 continues to decline over years. This is because since 2013 there is very ambitious air pollution control method implemented in China. So we can see the effects of PM2.5 level here.

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DR. YAN LIN: So from the urine collected from the subject, we have a very different exposure biomarker in the urine specifically for PAH where it first accounted by the level of hydroxy-PAH. We note the ability and also

the limitation of exposure biomarkers that it quantify the exposure from almost all the routes, including inhalation as well as dietary sources and other no air pollution sources.

I want to mention that in this study we have actively controlled no air pollution sources using experimental control. For example, for smoking, we have excluded all the smokers from the study, so that smoking is not a major influence factor here.

We cannot fully exclude the effects of secondhand smoke, which is likely to be higher in China due to the higher smoking prevalence. However, we measured urinary cotinine to post-hoc assess their secondhand smoke exposure.

We note diet is another important source of PAH. And especially for urinary biomarker, there was sort of time as the reason that we also make important contributions. So in our study, we have minimized the effects of dietary sources by collecting morning urine samples after at least fasting for eight hours. In addition, we also use questionnaire to collect important information -- collect information about their important dietary sources like barbecue intake.

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DR. YAN LIN: So this result shows the level of

total urinary PAH metabolites among the study participants. Again, the gray box here indicated data in Beijing, while the white box indicate data in Los Angeles. We can see clearly across different years, traveling from Los Angeles to Beijing significant increase the level of PAH metabolites. While returning to Los Angeles, will making those lab -- the increase go back to baseline.

And also, if we focus on gray box only, we can see a continuous decline of the PAH metabolite in the urine over years, which is perfectly consistent with the trend of ambient PM2.5 level. We also conduct association analysis between urinary PAH metabolites and ambient air pollution levels. And we found that PAH exposure markers was significantly associated with ambient NO2 and PM2.5 concentrations.

So taken together, this result suggests that hydroxylated PAH can perfectly capture the variability of air pollution exposure.

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DR. YAN LIN: Now, that we have a good choice to assess air pollution levels, what about source. We also -- in addition to the air pollution levels, we also mentioned that those test very unique pollution sources like petrogenic sources, as indicated by this news headline. So about one-third of the population in Los

Angeles will potentially exposed to petrogenic sources. So whether we have biomarker that can capture those changes in sources.

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DR. YAN LIN: Here we use hypothesis driven focused on particular hypothetical tracers for petrogenic sources, 2-methylated-phenanthrene[sic]. Based on previous literature, we have found that this chemical was more abundant in the petrogenic sources. Well, their abundance is quite lower in combustion sources. I think a logical explanation is that the combustion sources will generate is a highly oxidized -- oxidated environment. That could oxidize the methyl group in this methylated PAH, and therefore consume this chemical.

[SLIDE CHANGE]

DR. YAN LIN: And also based on the previous literature, especially those from environmental monitor studies, we can find that the ratio of 2-methylated-phenanthrene[sic] to phenanthrene was generally higher among environmental matrix that came from petrogenic sources. So then we think about if we can also quantify the metabolites of methylated phenanthrene and phenanthrene in the urine, we can potentially extend those diagnostic ratio from environmental samples into the biomonitoring status as a diagnostic ratio to distinguish

petrogenic versus pyrogenic sources.

The good thing is we already have good markers for phenanthrene, which is a hydroxy-phenanthrene. However, at that time, there is no biomarker that -- or specific to methylated-PAH.

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DR. YAN LIN: Then we tried to develop a method to measure urinary metabolites of methylated PAH. And the first step is to identify what's the metabolites of methylated PAH in human body? And from one in vivo study based on human liver microsome, we have identified such a biotransformation procedure. We have found that for the methylated phenanthrene, the metabolism only goes through side chain oxidation and the final product is a carboxylic acid metabolites of phenanthrene. However, at that time, it's not known whether this chemical existed in human urine.

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DR. YAN LIN: Therefore, we have leveraged our strengths and developed an analytical chemistry method and successfully identify those two carboxylic acids, metabolites of phenanthrene in the urine. As we can see, the signal is pretty strong in other urines as indicated by this chromatogram. Using this method, we have successfully detected these chemicals in more than 90

urine samples -- in more than 90 percent of the urine samples, we have collected from the travelers.

[SLIDE CHANGE]

DR. YAN LIN: And this figure shows that -- the special differences in traditional marker hydroxy-phenanthrene and also our novel markers between Beijing and Los Angeles. As we can see for both markers, there are significant increase in Beijing, which is consistent with mostly air pollution in Beijing and also demonstrate this novel markers also sensitive to changes in air pollution levels.

[SLIDE CHANGE]

DR. YAN LIN: Presently, we have calculate the metabolites ratio between carboxylic and hydroxylated metabolites of phenanthrene, which is a hypothetical diagnostic ratio of petrogenic sources. And we also found this ratio is quite sensitive to changes in the environment. As we can see traveling from Los Angeles to Beijing significant decreased the ratio. While returning to Los Angeles will make it go back to baseline.

And also, the higher level of this ratio also indicate higher contribution of petrogenic sources for the -- to the overall exposure. So this evidence provide indirect evidence showing that our markers could potentially used to quantify -- to estimate a contribution

of petrogenic versus pyrogenic sources.

[SLIDE CHANGE]

DR. YAN LIN: First of all, we have averaged the data from multiple years. We have also explored whether there were significant temporal change of those ratios across different years. And we can see in both Los Angeles and Beijing, this ratio was significantly increased from 2014 to 2017.

In Beijing, we have -- because we have pretty source apportionment result, we note that this increase in the ratio is mainly driven by the reduction in combustion sources or, other words, petro -- pyrogenic sources. However, we have no comparable information in Los Angeles, so we don't know which -- what -- whether it's the change of petrogenic versus petro -- which one drives this temporal trend.

But I think an interesting observation is that the increase in rate of this ratio in Los Angeles is higher than that of Beijing, which implied that maybe both the reduction in pyrogenic sources and the increase in petrogenic sources can make a difference here.

[SLIDE CHANGE]

DR. YAN LIN: I think -- so after this study, we still have a lot of unanswered questions. First, with -- in the Beijing Los Angeles study, we didn't collect any

information in the air. So we don't know whether those Metabolites in the urine can reflect air pollution exposure.

On the other hand, we also, as shown before, the biotransformation procedure can also influence the biomarker concentration, in addition to the exposure itself. So we -- that's why we conduct another study to further testing those two questions and see whether external exposure to methylated-phenanthrene can contributed to urinary carboxylic acid metabolize phenanthrene and whether the ratio in personal PM2.5 sampler are correlated with the hypothetical metabolized ratio in the urine.

In this study, we have recruited 120 adults in Beijing and repeatedly collected their personal PM2.5 samples and matched urine samples. So the association analysis was conducted to do -- to test those hypotheses.

[SLIDE CHANGE]

DR. YAN LIN: So this figure shows the correlation between the personal exposure and urinary metabolites. The pat -- the figure on the left indicate there will be positive correlations between personal exposure to PM2.5 bound to methylated phenanthrene and urinary 2-carboxylic acid metabolites phenanthrene.

Well, the figure on the right indicate there is a

positive association between the ratio in the personal PM2.5 samples versus those in the urine. So this evidence provides direct support that the metabolites changes in the urine can directly resulting from the changes in the ambient inhalation exposure to PAH.

[SLIDE CHANGE]

DR. YAN LIN: With -- and also, in Beijing, I think there is huge seasonal differences in the air -- in the nature of air pollution, because of the heating activities. In Beijing, the major pollution sources in the no heating seasons are traffic emission, while the major pollution sources in the heating seasons are coal and the biomass burning.

So that's why we stratified the data based on season and test whether the positive association was robust between the two seasons. And our results suggest that the relationship between ambient PAH and urinary metabolites could be changed at different times, along with different season with different pollution sources, which means there the exposure is not only a predictor of urinary metabolites.

[SLIDE CHANGE]

DR. YAN LIN: Therefore, we have also additional collect a couple of questionnaire data and see whether any other factors can influence the level of 2-carboxylic acid

metabolites in the urine. And here, we have identified two important factors that can influence the metabolites concentration. The first is the smoking history and the second is alcohol consumption. This literature we found that those two factors are also modulators of the biotransformation of 2-methylated phenanthrene, 2-carboxylic acid metabolites of phenanthrene.

Specifically, smoking can directly induce the -- can change the activity of cytochrome P450, and which is responsible the first oxidation of side chain. Well, the alcohol are also substrate of those ADH and ADHL. So that -- there -- alcohol can compete with the 2-methylated phenanthrene in the metabolism and therefore can also influence the concentration of their urinary metabolites.

[SLIDE CHANGE]

DR. YAN LIN: So for know, we have -- this is summary -- this list provide a brief summary about what we have -- the information we have gathered so far about those novel biomarkers.

First, we have provide direct evidence showing that urinary metabolites of carboxylic -- urinary carboxylic acid metabolites of PAH are mainly derived from methylated-PAH. And also because methylated-PAH is more abundant in the petrogenic sources, the ratio between carboxylic acid and hydroxylated-PAH can be used as a

diagnostic ratio to estimate the relative importance of petrogenic sources versus pyrogenic sources.

In addition, we have identified two important lifestyle factors, tobacco smoke and alcohol, as important modulated influencing factors of the level of those novel biomarkers. So we recommend to collect those two information in future populations that is to better control the effects of -- the effects of lifestyles on the biotransformation procedure.

[SLIDE CHANGE]

DR. YAN LIN: I think we're -- I'd like to acknowledge our extensive help from our collaborators Peking University, UCLA, and Duke, and also I want to acknowledge funding from multiple funding sources including NIEH.

[SLIDE CHANGE]

DR. YAN LIN: Thanks a lot for your attention and I'm happy to take any questions.

CHAIR SCHWARZMAN: Thanks so much. So similar to last time, we'll have both chance for questions, and then an open public comment period, and then a discussion, a longer time for discussion. So we'll start with questions from the Panel or from the audience about this talk. And we also have someone monitoring online. So if there's a webinar attendees who wants to ask a question, feel free.

It was a very thorough presentation. Okay. One question here.

PANEL MEMBER LUDERER: Yeah. Thank you for that presentation. It's very interesting. I think it seems that one of the things that's really also demonstrated by your presentation that I was struck by is how much overlap there is between these, you know, different biomarkers, so -- and which obviously relates to the fact that people are exposed to these -- to PAHs via so many different routes -- multiple different routes, right? And I was wondering, you know, how -- teasing out the relative contributions of each of those sources, you know, even with these biomarkers is very challenging. I just wonder if you could comment on that some more.

DR. YAN LIN: Yeah. Thank you. That's a -- that's a really nice question. I think for biomarker I think for the recommendation of the use of biomarker, we have -- I think there will be two scenario. I think one scenario is that we use biomarker to quantify the total amount of exposure and to understand where this exposure came from, like which -- in this way, we can try to understand whether dietary sources are more important or inhalation sources are more important. In this -- if this is the purpose, I think we are just -- we can just go ahead and collect urine samples for the measurement of a

biomarker and also link them to different exposure route that can better understand where this chemical came from.

And another scenario that we want to use biomarkers, we tried -- we employed is -- as the truth to -- for us to assess specific sources. In this way, I think definitely air pollution will -- like, if air pollution is something we want to study, we really want to do something to minimize the effects of other sources like dietary and like smoking. So if this is the case, I would recommend we do more experimental control or provide guidance to the subject who'll donate the urine to avoid getting exposed from other sources.

In this way, the result can be directly used to inform their -- to what extent they were influenced by sources. So that's -- will direct to different purpose of the markers and will rely on different study design.

CHAIR SCHWARZMAN: So I could check for -- oh, we have another question. Sorry, Kathleen.

PANEL MEMBER SUÁREZ: I might have a question online too.

DR. KATHLEEN ATTFIELD: And sorry, I'm right behind you with the camera.

My question is around the sort of relative half-lives if you're thinking about exposure -- like trying to diagnose exposures from one source versus

another source and whether you have a recommendation on sort of how many samples you would want to take per person to sort of get an idea about perpetual exposures, because, you know, diet can change from one day to the next and that would definitely impact your PAH levels.

DR. YAN LIN: I think that's a really challenging question. And to be honest, I don't have a direct idea about the sample size will require to get that one. But I think some information we can share is that we do find those dose biomarker has pretty -- it's not -- it's less influenced by those genetic factors like who you are. So that we are -- we don't rely on like super longitudinal design to control -- to make subjects more in control. And this marker can be good use to focus sectional study.

And I think the sample size is really depends on the strengths of the exposure. Like, if you have a huge exposure from like a gas or oil drilling, I think that small sample size will be adequate. But if you -- but if the signal -- or the contribution of gas and the source of interest is a relatively minor or moderate source compared with other source, I think we'll have that and have a larger sample size in order to detect a difference.

CHAIR SCHWARZMAN: We had a question from José.

PANEL MEMBER SUÁREZ: Yeah. Hi. Hi, Yan. Very interesting -- very interesting presentation. I really

enjoyed the part where you're including students to be part of your subjects there and these time trend visits, and looking at how that really -- how the different methods that you're using is sensitive enough to stratify and detect the differences in these exposure levels.

So just a question. How -- for -- so for example, you have some of the VOCs here, the methyl, what is it, PHE versus the non-methylated versions, what are the half-life differences in the body versus in the environment in the air, and linked to that, of course, would be how much within individual variability would you expect versus like a between individual variability. And the third question, which is all sort of linked to that, so kind of how wide of an exposure window is a measurement giving us?

DR. YAN LIN: Yes. Thank you. That's -- all these are really nice questions. So let me answer the first question. I think it's about the biological half time. And I think there will be direct evidence to support that. For the hydroxy-PAH, the half-time is around 10 hours. And there will be -- for now, there is no much information about biological half-time of those novel markers, the carboxylic acid PAH. That we do compare -- conduct a preliminary test about a tense objective that weeks exposed to extremely high level of

air pollution.

I think our preliminary data indicate that the half-time of carboxylic acid metabolites also within 24 hours, which means I think for both markers, they are pretty short term and I think that's also consistent with the fact that there is a good amount of both biomarker in the urine. So in this case, I think definitely the exposure window for this marker will be around recent 1 to 0 day, something like that.

And also for the -- for the half-time of PAH in the atmosphere, I think it depends on the phase, like if -- if the PAH exists in the gas phase, I think they are -- they also short half-time because the solar radiation can provide a very strong force for them to degradate, and also some atmosphere oxidant like free radicals can also break down those PAH. But if those PAH respond to the particles, I think they can be pretty persistent, because some other soot can cover the surface of particle matters that can prevent the degradation of those PAH. So it really depends on whether they exist in the gas and the particles. Sorry, may I -- could you repeat the question -- the second or the third question.

PANEL MEMBER SUÁREZ: No, I think -- I think you got it. So I guess the second one was more looking at individ -- within individual variability versus like

between individual variability, which typically tends to be very related to the half-life of what it is that you're measuring.

DR. YAN LIN: Yeah. Thank you.

PANEL MEMBER SUÁREZ: Thank you.

CHAIR SCHWARZMAN: Yeah, Amy.

PANEL MEMBER PADULA: Thanks so much. This is a really interesting study design. I was also wondering if you have considered testing even -- especially within the LA -- time during LA, when -- in between times when maybe there would be more petrogenic sources versus times when wildfire smoke might dominate the air pollution, and whether you could see the patterns between those two periods. Yeah, that's my question.

DR. YAN LIN: That's a really nice question. And also, the short answer is we do consider about that, but I think our example is not due to answer that question, because for -- because our study cohort, like UCLA student, is highly clustered. Almost all of them was resident in the -- nearby UCLA, so -- near UCLA, so that there will be a long call for spatial variability in those sources. And also, for all the collection, we have conducted in a short -- in a narrow kind of window in either just before and after the summer. So we also then cover up a good temporal coverage to capture those

wildfire episode.

So we hope we can have opportunity to have a better temporal or spatial coverage probably in a future study among most of the residents to capture that wildfire episode on those biomarkers.

CHAIR SCHWARZMAN: I need to check in about public comment and then we'll move on to the discussion. Rebecca, was there something?

REBECCA BELLOSO: No.

CHAIR SCHWARZMAN: No. Okay. In that case, we have just under a half an hour for a discussion of this topic that both presenters contributed to. And to get the conversation started, I want to read a series of questions that the program has provided that touch on the questions that are coming to them as they consider how to study this topic.

So when conducting a biomonitoring study around oil and gas exposures, there's a few issues that the Program would love to have us weigh in on and then any other discussion points that anyone wants to bring up are fine too. So the first is the Program is aware of heavy metals, PAHs, V -- and VOCs as analytes of interest in communities living near oil and gas fields. Are there any additional analytes that the Program should consider?

The second one is does the Panel have any

recommendations on assessing cumulative impacts, particularly when interpreting results and discussing results with participants?

The third is we heard today that LA County communities are heavily impacted by exposure to toxics from oil and gas activities. Are there additional communities or areas in California that the Program should consider biomonitoring for oil and gas exposures?

And finally, are there any gaps in the literature that the Program should consider or further research that's needed before initiating a biomonitoring study in these communities?

I can refer back to those. I think you're trying to bring them up, so they might be on the screen soon, but also we can refer back to them as needed. Anyway, if that sparks discussion, that sounds like those are priorities for the Program beyond that.

Oliver.

PANEL MEMBER FIEHN: Yeah. Hi. Oliver Fiehn, UC Davis. I was happy or lucky to collaborate with Yan Lin on the cumulative impacts on the exposures that he just presented. He did not talk about it --

(Laughter).

PANEL MEMBER FIEHN: -- but if, you know, I may paraphrase, we look at the cumulative impacts on both

oxidative and -- or inflammatory and anti-inflammatory results in plasma from these people, as well as triglycerides. So we saw very clear differences in metabolic impacts in the study participants as, let's say, associated with the exposures, but, you know, with the same study design. And therefore, I think it might be good to look at those things as well in other exposure studies just -- not just exposure, but also how does it change -- significantly change in body fluids of participants.

CHAIR SCHWARZMAN: Other comments on or discussion points on these topics or others related to initiating a biomonitoring study of oil and gas exposures exposed to communities.

PANEL MEMBER SUÁREZ: Just a quick question here as a follow-up to Oliver's comment there. Are you thinking more of something a little bit more mechanistic, like the short-term effects of these different on maybe like a subacute effect or maybe even a very acute effect of the different concentrations in serum or whatever biospecimen, urine, in relation to inflammation markers triglycerides? Is that what you were trying to get at?

PANEL MEMBER FIEHN: Yeah. In a way, you know, that's I think important at the end of the day, not just to know what we are exposed to that much, but also how it

affects the body. And there are methods today that, you know, there can be different methods used obviously to assess that. But I think, you know, particularly to the number two, right, that is a cumulative impact. And when you go back to participants and say, well, we have that, and we also have information how it may change specific metabolites that have impact on health and these so-called lipid mediators that we measured with Dr. Yan Lin.

And so that might be also informative for participants. They might want to know that, right? And so that was a unique study where both of that could be investigated. And I just happen to know it, because I was partnering in that study, but I, you know, could imagine that this type of analysis and maybe other types of markers might be informative in terms of what does it mean to be exposed to something?

CHAIR SCHWARZMAN: I have a question that's maybe for Program staff or other people who are aware of -- more aware of the research in this area than I am, as you contemplate a study, is the comparison community generally people in -- like it's all about proximity to the production, so you're comparing people who are closer -- living or working closer to it than people who are farther way, but in the same region. I think that's how most of these studies are done around oil and gas exposures. And

I'm wondering how folks who have already worked in this area manage the issues of location of work, and -- like and occupation, and how that might do -- exposure misclassification comes in with those questions, how is that generally controlled in these kinds of studies?

Any thoughts on that?

STEPHANIE JARMUL: I guess I can say a little bit about that. Stephanie Jarmul from OEHHA.

I believe it's one kilometer is considered living near an oil and gas facility. One of the studies also out of UCLA I believe use that as their parameter. And I think it depends on what your question, in terms of like who your control population is, because, you know, LA is a very unique situation, but there might be some other communities in California who would have different variety of exposure sources. And even with Yan's presentation, we're really interested in that, because that might at least give us the opportunity to help distinguish between the petrogenic and the pyrogenic sources, so being able to tease out are these exposures coming from the proximity to oil and gas or is it from like nearby traffic, because that also obviously heavily impacts LA. So would we want to control a population that is further way from traffic sources and just near oil and gas facilities? These are all questions that we're kind of pondering.

CHAIR SCHWARZMAN: And what about location of work and what work folks do?

STEPHANIE JARMUL: You mean, what type of work they do or the location of their work itself?

CHAIR SCHWARZMAN: Both actually, but I'm thinking for such a location-based study you need to know where people go during the day.

STEPHANIE JARMUL: And that is something we can consider. We did that for EBDEP, I believe. We did sort of -- we maybe even had a tracker that they wore to sort of track where they were going on each day that they were involved in this study. And so I think we're actually working through some of that data right now and help us to -- if we were interested in doing that in the future.

CHAIR SCHWARZMAN: Another thought, and I don't know this literature super well, but I know you do because you use this, is silicone wristbands as a way of like helping stratify exposure groups. And you don't have to know so much about where they went, because if you have this sort of passive monitoring method to sort people, if you know that the petrogenic sources travel with something that you can measure in a silicone wristband. I'm getting a little vague here, but as a concept.

STEPHANIE JARMUL: That is certainly something we're interested in. I'm not as clear if PAHs themselves,

what they're, you know, absorption rate would essentially be in the wristbands. We are just now working through our very initial, you know, pilot testing of the wristbands for the FRESSCA study. So we're hoping to learn more a bit about that, but that is definitely something we're interested in pursuing in further studies. I know they've been used in many studies and have had problems seeing results. But I'm not as clear with the PAHs specifically in the silicone wristbands.

DR. YAN LIN: Yeah, I think I can add some information about the PAH in the wristband. Actually, we do have some concern in measuring PAH in the wristband. I think they are pretty good in getting us a result. Like if we wear a wristband for around one days and in a typical situation we can get good amount of PAH. But most of the PAH we can detect, it's not just two, three, and four rings PAH. And for those heavy ring PAH, like BAP, they are typically not detectable for wristband. So that's some information we can share.

SUSAN HURLEY: Hi this is Susan Hurley from EHIB. I was just thinking back to one of the comments that Jill made in her presentation, which was I think it was in the South LA study where you mentioned that the air toxic levels went down when the drilling stopped. And so that that was -- that you could see that even in a community

where there's a lot of traffic.

And so I'm thinking is there any way to design a study that takes advantage of that? Like are there planned like times of non-operation, given that a lot of these biomarkers have short half-lives? I'm wondering, if, you know, we could design something around that. I don't know enough about gas and oil development to know if that's even a possibility.

DR. JILL JOHNSTON: With that, I think there's some wells that are planning to sort of phaseout production, at least in LA County. I'm not sure about Kern County. But, I mean, that could -- that's sort of what we leverage, right, to look at the -- when the well was producing versus when it went idle. And so, you know, I think there's potential to leverage those opportunities as it's anticipated, like more wells are going to stop producing, you know, over the coming decades in LA to try to like examine those changes.

I think one other thing to keep in mind, this is -- there's like other issues us, is just there's really different control technologies used on different well sites in LA. And so, you know, in that case the exposures amy not all be equal, depending on sort of what neighborhood you're looking at. And so I don't -- that hasn't really been fully explored. And there's been air

monitoring studies around Baldwin Hills and one that's going to start in the La Cienega oil fields in the South LA oil field. And then there's been some work out in Kern County as well. And that could potentially offer insights as they measured like a whole large suite of VOCs.

CHAIR SCHWARZMAN: I had a question about other factors affecting indoor air quality. Because if we're looking at residents and residential proximity, then there's so much variation in indoor air quality and the factors that affect it. And, you know, I know in the studies that the program is working on around wildfire smoke exposure and interventions, there's also just this, you know, use of indoor air purifiers and different types of indoor air purifiers as an intervention arm of the study.

And I just raise it as a point of consideration with this either as a -- as an element of the study or how to account for differences in people who may be living within a kilometer of the oil and gas extraction site, but may have very different factors affecting their indoor air quality, like air purifiers, and how you might incorporate that into questionnaires to make sure it's not mixing groups.

STEPHANIE JARMUL: I think we would definitely want to include questions around that in our surveys of

participants. And luckily, we have a lot of those questions already from our previous studies. That's always a big concern is these other sources of exposures, indoors especially. So yes, that is something we will make sure that we look into.

And then I'm also -- I believe maybe Jill knows a little bit more about this. I thought there was some legislation that was introduced to reduce maybe emissions in I don't know if it was LA County. I don't know, Jill, if you're familiar with this in the next few years having to deal with the different proximities to the oil fields? And that might be something interesting to look at too, if we're able to -- I'm not sure of the timeline, if we're able to get out there before and after. That's something else we can consider.

DR. JILL JOHNSTON: So, in -- last year, LA City and LA County passed a phaseout. Right now, it's about a 20-year phaseout for oil and gas drilling. It was declared incompatible land use. Most of the wells that would go offline are sort of individual ones, so they happen as a result of lawsuits or as well as a result of like added permitting requirements on them that may change, right, what kind of control technology is being used. The statewide legislation was the 3,200-foot one, but that hasn't been implemented yet.

NANCY BUERMEYER: I don't know the details of it, but there is a bill -- Nancy Buermeyer, Breast Cancer Prevention Partners -- about idle wells and capping idle wells. That's pending now. I'm sorry I don't know more than that, but...

CHAIR SCHWARZMAN: Did you have something, Amy? Please.

PANEL MEMBER PADULA: I had a few comments to sort of follow up on a few threads that have been going. But one was, yeah, there have been other studies similar to Jill's by David Gonzalez and others on oil wells that have closed and then the changes specifically in air pollution. And I think that also just brings up -- I think -- I was struck when I was reviewing some of this work is that of -- about just the cumulative exposure. So it's not, I think, as important as it is to kind of find out what's really coming from the well itself, but also the trucks that bring the oil, and now all of these other kind of additional pieces. I think if there's a way of kind of creating metrics that account for the cumulative nature of them.

And then also I agree about the importance of understanding infiltration of these pollutants into the indoor air. And I think in addition to air purifiers would be information on air cooling systems, whether

they're filtered or not in that process, especially in LA, given the heat considerations. So, yeah, in addition to kind of other housing factors, that cooling would be something I'd want to include.

CHAIR SCHWARZMAN: José.

PANEL MEMBER SUÁREZ: Yeah, this question is for Jill. And first, Jill, thank you for that presentation and the wonderful work. I would like to disclose that in my graduate level course of environmental and occupational health at UCSD, we used one of your publications, the 2021 about respiratory health, as a case study and students love hearing about it. It's an eye-opening for a lot of people to realize that there's so many oil wells within LA proper.

Today, we've been hearing about PFAS as well. And I know that PFAS have been measured in air in large manufacturing plants in general. What do you know about the use of PFAS for oil extraction?

DR. JILL JOHNSTON: Not very much. I have been told it's used especially like in drilling fluids when they do injections with PFAS, but I have not kind of studied it or analyzed it in anyway. So sorry, I can't be more useful but, yes, thank you for your comments.

CHAIR SCHWARZMAN: Any other comments or points of discussion on this before we go to an open public

comment period on all the content from today?

STEPHANIE JARMUL: We do have a member of the public that would like to speak. I'm not sure if it's for this item or for the open public comment period, but Dr. Sumchai if you wanted to unmute and speak.

DR. AHIMSA PORTER SUMCHAI: Dr. Ahimsa Porter Sumchai. I am the founder and the director of the Hunters Point Community Biomonitoring Program, the foundation and the toxic registry.

With regard to the item on the agenda, I just point -- wanted to point out that the Richmond, Martinez area of Northern California is an area where there's a heavy concentration of refineries and also point out that there was legislation that was proposed that would create buffer zones around oil and gas refineries, specifically those that are sited near day care centers.

I wanted to speak very, very briefly about the findings of the five-year Hunters Point Community Biomonitoring Program and our creation of a toxic registry. The Hunters Point Biomonitoring Program was launched in January of 2019 and we use a kit that is capable of detecting 35 potential toxicants, including chemicals of concern documented to be present at a federal Superfund site, in addition to chemicals that are listed on the Proposition 65 list of carcinogens and chemicals

that cause reproductive harm.

In the five years since we have launched, we have been able to geospatially map a community within the one mile perimeter of a system of federal Superfund sites. And our findings identify basically that the risk of exposure is factored by two parameters, how close you live to the base and how long the duration of exposure. Most of the people who we have entered into the registry, the registry consists of 100 people, 85 residents, the majority of whom currently live within the half mile perimeter of the federal Superfund system and 15 UCSF workers, current and former, who are located on the Naval base within 200 feet of the landfill. And of that group of 100 people, that cohort, all of them have risk of exposure evidence or proof of exposure and adverse health effects.

The chemicals that we are detecting are chemicals that are documented by the EPA and the Navy to be present in soils at the federal Superfund system, as well as chemicals on the Proposition 65 list. The most commonly detected chemicals above reference range are manganese, vanadium, thallium, nickel, gadolinium, rubidium, arsenic, and then we have chemicals on the Proposition 65 list, including lead and chromium, cadmium, vanadium, and radionuclides.

We have also conducted speciated urinary screenings capable of detecting radioisotopes. And we have detected radioactive potassium, a progeny of plutonium, as well as a progeny of uranium and cesium. So we are working right now to formalize the registry to develop the type of funding that it needs for advocacy and protecting people who are currently living and working within the one-mile perimeter of the federal Superfund system.

Thank you very much.

CHAIR SCHWARZMAN: Thank you for that. Is there any other public comment?

DR. SHOBA IYER: Hi. Shoba Iyer, San Francisco Environment Department and previously a toxicologist at OEHHA working on Biomonitoring California.

I have a couple comments I want to make that could be suggestions for a couple of the questions. Some of you might remember that I shared information about quaternary ammonium compounds in years past. And they are a chemical class on both the Designated and Priority Chemicals list. When I was looking at potential for exposure to these compounds, I did see that there are quaternary ammonium compounds used as oil field biocides and corrosion inhibitors in oil and gas operations. So that might be a chemical class to consider in terms of an

analyte.

And then in that research I had done, I was collaborating with an OEHHA colleague who was familiar with a database of chemicals used in fracking and oil and gas operations that I think at the time was housed by DOGGR. It's an acronym -- State acronym I don't remember what it is. And now I think it might be the Department of Conservation, but there could be other State resources for looking at what other potential analytes might be to evaluate as well as locations of oil and gas wells.

CHAIR SCHWARZMAN: Any other final comments or anything on the web?

Any attendees?

In that case, we can wrap-up the meeting. I should announce there will be a transcript of the meeting posted on the Biomonitoring California website when it's available. And the next SGP meeting will take place on July 19th, 2024 from 10 to 4 -- 10 a.m. to 4 p.m. And options for attending that meeting will become clear as the date approaches and will be posted on the website or sent out to the -- to the mailing list.

Biomonitoring California will, as you've heard, hold a 15-year anniversary celebration upon adjournment of the meeting. And I want to thank as usual the staff for putting together an amazing meeting, and the audience,

and, of course, the Panel members as well and adjourn the meeting.

(Thereupon the California Environmental Contaminant Biomonitoring Program, Scientific Guidance Panel meeting adjourned at 3:54 p.m.)

CERTIFICATE OF REPORTER

I, JAMES F. PETERS, a Certified Shorthand Reporter of the State of California, do hereby certify:

That I am a disinterested person herein; that the foregoing California Environmental Contaminant Biomonitoring Program Scientific Guidance Panel meeting was reported in shorthand by me, James F. Peters, a Certified Shorthand Reporter of the State of California, and thereafter transcribed under my direction, by computer-assisted transcription.

I further certify that I am not of counsel or attorney for any of the parties to said meeting nor in any way interested in the outcome of said meeting.

IN WITNESS WHEREOF, I have hereunto set my hand this 2nd day of April, 2024.

JAMES F. PETERS, CSR
Certified Shorthand Reporter
License No. 10063